Why Gemini Was the Astronauts' Favorite Ride

AIR & SPACE

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CHIPMUNK

50,000 Pilots Can't Be Wrong

The Cold, Hard Truth About Cosmonaut Landings

(p. 20)

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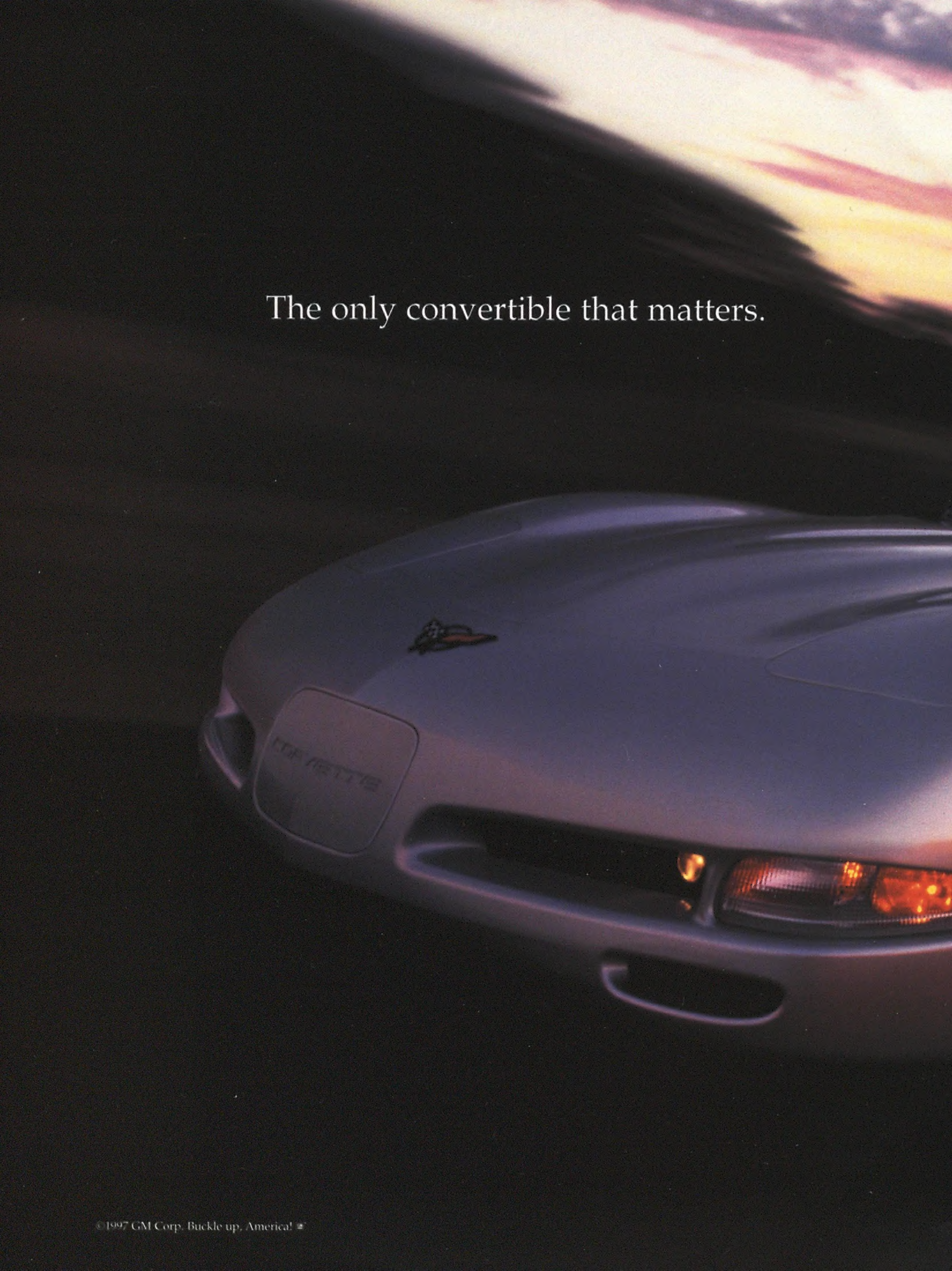
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The next Vette.

August/September 1998
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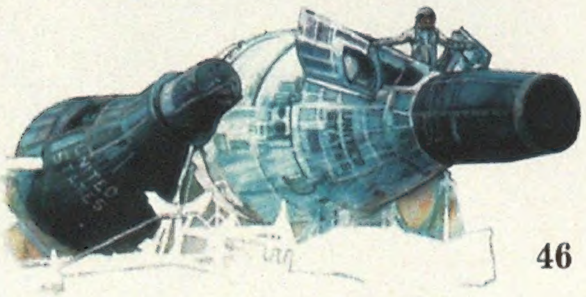

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BUSINESS WINGS
by the editors of
Air & Space/Smithsonian
To commemorate a new exhibit at the National Air and Space Museum, this eight-page insert looks at the productive partnership between business and aviation.

Cover: Rob Tomlinson flies his 1950 de Havilland Chipmunk over the Virginia countryside in this photo by Tim Wright.

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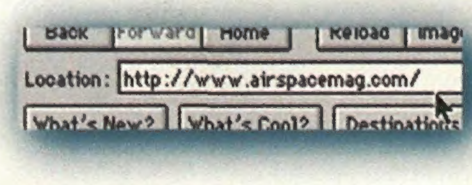

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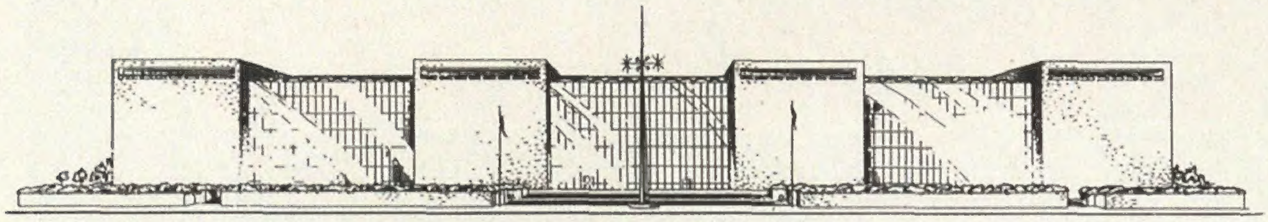
VIEWPORT



Attic Treasures

The Paul E. Garber Preservation, Restoration and Storage Facility is an integral part of the National Air and Space Museum, but our friends think of it as our attic. The Garber Facility is featured regularly in *Air & Space/ Smithsonian* and has been the subject of countless television reports, and all for good reason: It has everything an air-and-space buff would ever want to see.

Located in Maryland just 15 minutes from the Museum, the facility is named in tribute to Paul Garber, the founder of the national aerospace collection. It was Garber's tenacity and acumen in gathering and preserving early aircraft and spacecraft that led to the creation of the Museum itself. Today, the Garber Facility holds a large part of the Museum's 87-year-old collection of air and space artifacts. (If you include a group of Chinese kites donated during the United States' 1876 Centennial, the collection activity actually spans 122 years.)

This treasury of artifacts is truly one of our nation's most valuable assets, and one of its greatest values is its completeness. There is nothing else like it in the world.

The collection now contains 356 aircraft, over 100 space-related large artifacts, and tens of thousands of other items: memorabilia, engines, historic documents, and more. The Museum on the Mall displays 65 of the collection's aircraft. An additional 70 are on loan and can be seen at other museums in this country and around the world. That leaves over 200 aircraft at the Garber Facility, where they are stored in varying degrees of assembly. With the support of the nation, we are in the process of designing and will soon begin building a new restoration center at nearby Dulles International Airport, so that these artifacts can be seen more easily.

On a June weekend this year we held a two-day open house at the Garber Facility to display as many of our artifacts as we could. Visitors came from across the nation to see the part of the collection that's not on view in the Museum. Mom and Dad had the opportunity to show the kids something about airplanes and spacecraft, as well as the equipment that makes them work. It is amazing how standing next to the real article can bring a young person's mind to life. But it was not all kids' time—grownup visitors enjoyed it too.

The open house was also fun for the staff, and they worked hard to ensure that the visitors enjoyed it and learned something as well. The senior aeronautics curator, supported by many volunteers, helped kids make kites. Model airplane builders were on hand to demonstrate their professional work. Docents offered a fun remote bomb release system to test the relative motion skills of both kids and grownups. Your friendly *Air & Space* editor, George Larson, and other staff members spent hours helping young future pilots into and out of jet cockpits for photo opportunities, and the open air made the hot dogs and hamburgers all the more delicious.

Most of our aircraft engines were on display, as were selected archival papers. Roscoe Turner's pet lion, Gilmore, now stuffed and mounted, was there for all to see, standing beside *Miss Champion*, the Laird Turner racer that Roscoe Turner flew to victory in the Thompson Trophy Races in 1938 and 1939.

The open house benefited us as well, in ways we hadn't anticipated: In the course of dusting and cleaning the facility to prepare for the visitors, we found some parts we had been looking for.

It is unfortunate that more visitors could not visit this display of the seldom-seen portion of this wonderful collection. If you were unable to make it, the next best thing would be to visit our constantly growing Web page at:

www.nasm.si.edu

and take your own personalized tour through our collection and the Museum. There you will also find plans for the next-generation restoration and museum facility, the Dulles Center.

—Don Engen is director of the National Air and Space Museum.

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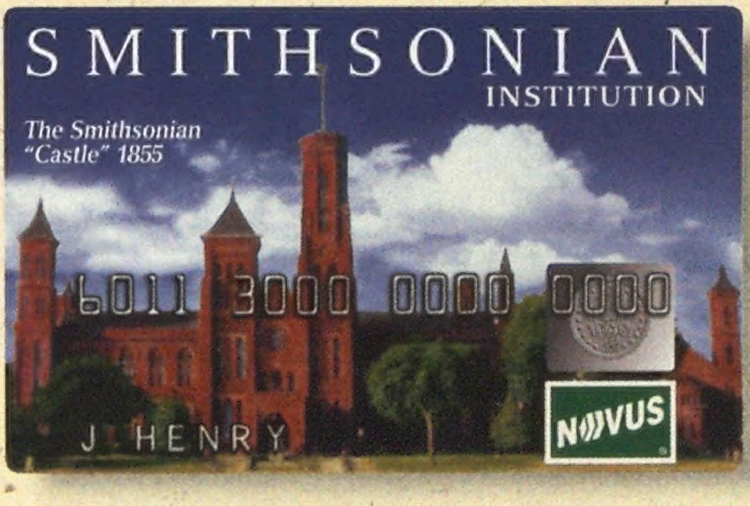

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LETTERS

A Family Reunited

Reading "The Return of the Lost Air Crew" (From the Field, Apr./May 1998) brought tears to my eyes again. The radio operator on that mission was my brother, Corporal Joseph Petrella. In 1994 we received word that the wreckage and remains had been found. We did not have closure for four more years. On January 10, 1998, we had my brother buried with a full military service in our veterans' cemetery in Cape May County, New Jersey. There was a very large turnout. Two weeks later, the families of all five crew members—pilot Fulton P. Lanier, copilot Frank M. Ramos, assistant radio operator Bartholomew R. Giacalone, crew chief Eugene Beebe, and my brother—gathered at Arlington National Cemetery for burial of the remains that could not be identified. It rained that day, but it was still wonderful to attend the services and meet the members of the other families.

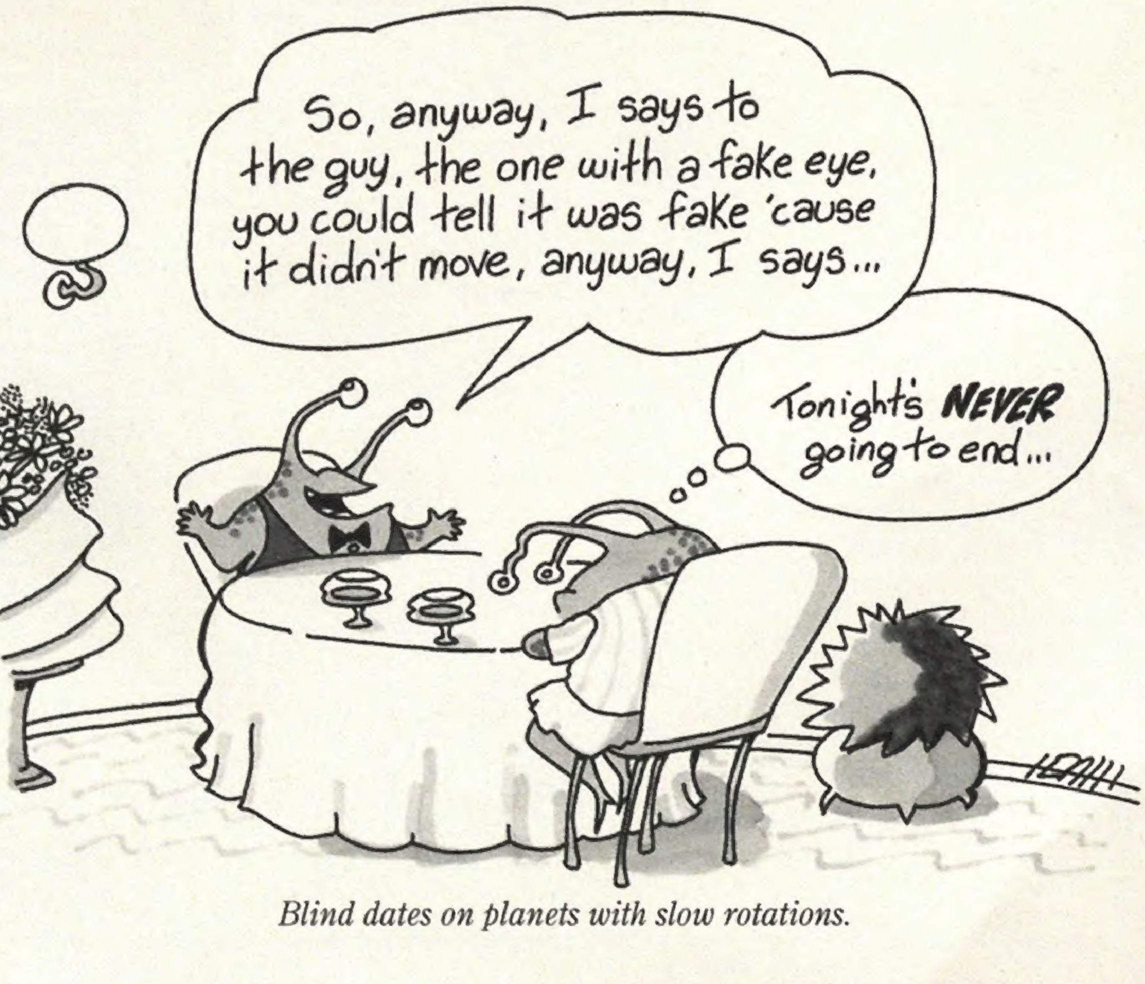
—James Petrella Sr.
Seaville, New Jersey

Put Away the Welcome Mat

Having recently returned from Midway Atoll National Wildlife Refuge, where I participated in a study of Spinner dolphins through the Oceanic Society, I must take issue with Keith Mount's letter in the last issue, in which he criticized the Fish and Wildlife Service's work on the atoll ("The Battle of Midway, Round Two," Apr./May 1998). Since Mr. Mount believes that "[a]ny plant or animal species that can thrive in a particular area has as much right to be called indigenous as any other," I wonder if he supports the presence of the Mediterranean fruit fly in Florida, the European corn borer in Iowa, or the rats that eat the Bonin petrel's eggs and chicks on Midway.

Until he has been there, done that, and knows whereof he speaks, Mr. Mount should stop spouting off. The Fish and Wildlife Service is doing an outstanding job on Midway.

—Charles Bendixen
Lincoln, Nebraska



Blind dates on planets with slow rotations.

Unidentified Floating Object

After my mother died, I found this photograph of her, taken in the late 1920s in front of a floatplane at McKinley Beach in Milwaukee. A note on the back refers to the craft as a "Milwaukee mfg. plane." It has a square fuselage, corrugated skin, and a single engine. I wonder if any of your readers can identify it.

—Joseph R. Haley Sr.
El Sobrante, California

Damn Yankees

The story of our Arrow ("Fallen Arrow," Apr./May 1998) and that of Britain's remarkable TSR-2—cancelled in 1965, scarcely six years after the program was launched—have the same plotline: Governments amicable to the United States terminated very advanced aircraft development, gutted their own aerospace industries, and then quietly purchased American products as replacements (Bomarcs and F-101Bs here, F/B-111s over there). It doesn't take a conspiracy theorist to draw some conclusions. You Yanks make great planes, but why do you have to bust the chops of everyone else who does?

—Ken Steacy
Victoria, British Columbia, Canada

Bigfootnotes

The phenomenon of hydroplaning remained unstudied until B-58s did it with their 24-tire main gear ("Bigfoot," Feb./Mar. 1998). At NASA's Langley research center in Virginia, Upsher "Uppy" Joyner and Walter Horne came up with a formula that always proved true: Hydroplaning occurs when landing on a wet surface at a speed, in knots, above nine times the square root of the tire pressure (in pounds per square inch).

During the mid-1960s, we at Thompson Aircraft Tire worked on the hydroplaning problem by evaluating a variety of tires: smooth, multi-grooved, and our own "wiggle tread" product. We found that regardless of tread rubber composition, tread grooving, or tire baldness, Uppy and Walt's formula always held true.

In addition to figuring out the problem, the Langley center came up with the solution: the grooved runway.

—Bill Protzmann
Fallbrook, California

When I worked at Boeing on the B-52, I thought the most interesting part of the plane was the landing gear. Whenever the plane was up on jacks and the crew would exercise the

gear, I would watch spellbound. The gear was stowed in tandem—one strut in front of the other—but when it was deployed, it came down side by side.

Even more amazing was that it was crosswind gear. Using a large knob located just behind the throttles, the pilot could get the gear pointing straight down the runway while the airplane "crabbed" into the wind (faced diagonal to the runway).

—Bill Reich
Acton, Massachusetts

GPS—No Panacea

In his letter in the Feb./Mar. 1998 issue, Jack Block argues that the military should give the public access to GPS's three-meter-accuracy signal. Mr. Block apparently suffers from the "technology will cure all" mentality.

Rather than build new runways to increase airport capacity and accept the heat from anti-noise groups and other special-interest organizations, these individuals ignore the lessons learned from accidents and other incidents. They believe they can painlessly double system capacity by relying on such things as new-generation radar with increased resolution, special procedures to ensure "safe separation" of aircraft (even those with 100 percent fail rates in simulation and testing), and traffic management specialists browbeating controllers and pilots to accept minimum spacing. Unfortunately, their solution ignores (1) wake turbulence encounters; (2) limitations on the pilot's ability to visually maintain proper spacing from the preceding aircraft while flying, reconfiguring the aircraft for landing, completing checklists, and navigation; and (3) the possible lack of an effective escape maneuver and path that the pilot can use when things do go wrong.

Recently, while going into the Seattle-Tacoma airport, we were told to follow traffic we could not readily identify over a landmark we didn't know, all while flying with a speed restriction in windshear conditions. We encountered wake turbulence from the preceding aircraft (which was on a visual approach to the other parallel runway), and as I fought to stabilize the approach, we got a TCAS resolution advisory—from an aircraft that was supposed to be following us—that directed us to start a 2,000-foot-per-minute rate of descent, even though we were at only 2,500 feet above ground level.

Mr. Block, greater GPS accuracy would not have helped us at all.

—Jeffrey A. Gorman
Walton, Kentucky

Getting Out, Any Way You Could

I took part in Operation Frequent Wind on the USS *Midway* and was surprised that Richard A. Macdonald's article "Escape from Saigon" (Above & Beyond, June/July 1998) did not mention that some of the helicopters used during the evacuation were flown by Air Force crews and maintained by Air Force personnel.

Six Air Force CH-53s and four HH-53s (two of which were later replaced by larger-capacity CH-53s) took part. Air Force and Navy personnel worked around the clock, hot-refueling the aircraft and doing whatever else it took to keep them going. At times, Vietnamese helicopters had to be pushed overboard to make room for helicopters coming in on emergency fuel. A couple of the aircraft flew more than 20 hours. All told, the Air Force helicopters ended up carrying more than 2,000 people.

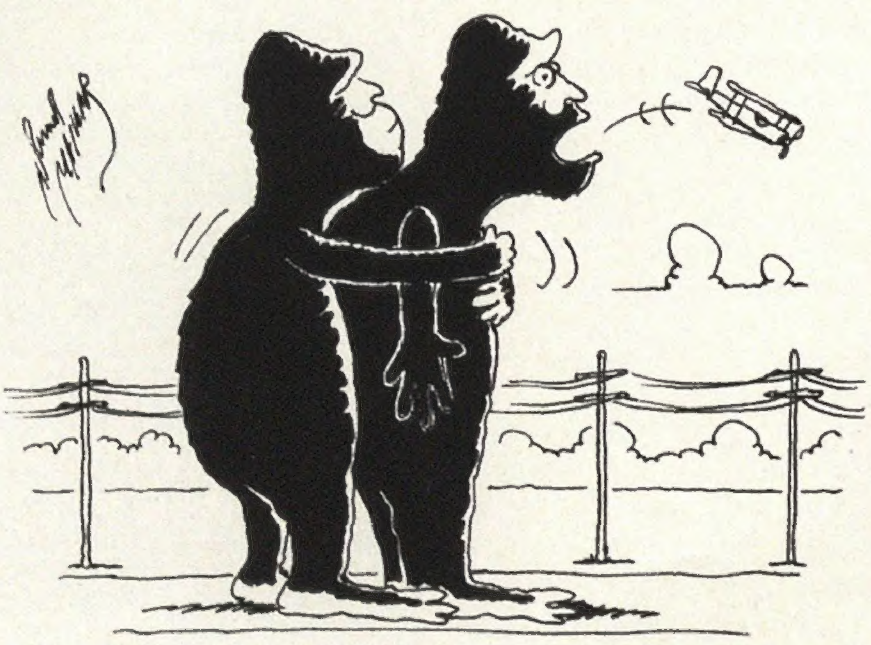
I also remember when that O-1 wanted to land on the *Midway*'s flight deck. The Navy was hesitant about this and first put the *Midway* into a tight turn, which created a circle of calmed water in which the O-1 was to ditch. Of course, with children aboard his tiny, frail aircraft, the pilot refused that option.

—Senior Master Sergeant James Duffy
U.S. Air Force (ret.)
Clinton, Utah

"Escape from Saigon" included a beautiful photograph of Northrop F-5s on a carrier flight deck. How did they get there? The F-5 wasn't built to land on a carrier.

—Frank Merrell
Santa Maria, California

Editors' reply: After the evacuation, the South Vietnamese F-5s and A-37s were loaded onto the carrier by crane at the U Taphao air base in Thailand (see "Escape to U Taphao," Dec. 1996/Jan. 1997).



A Mysterious Prank

After seeing the picture of the Bonanza flying under the Eiffel Tower (Sightings, Dec. 1997/Jan. 1998) and reading in the following issue the letter objecting to the flight, I thought I'd add fuel to the fire.

Shortly after VE day, a certain pilot led a flight of four P-47s under the tower. He was not after publicity; let's just chalk up the flight to youthful exuberance.

This pilot was also the model of a minor character named Tennessee (played by James Holden) in the 1948 movie *Fighter Squadron.* Not particularly Academy Award material, the movie did have some nice shots of P-47s and a few P-51s decked out as Bf 109s.

—Bob Webster
Hardin, Kentucky

Working Hard or Hardly Working?

While on assignment as a photographer, I would visit with the reporters covering the Navy's Vanguard program ("A Launch Down Memory Lane," Soundings, Apr./May 1998), and they used to tell this joke:

"Did you hear that they're going to change the name of the Vanguard to 'the Civil Service?' "

"Why?"

"Because they can't make it work and they can't fire it."

—David N. Pfaff
Naples, Florida

New Life for the 262

I was delighted that "Watson's Whizzers" (Oct./Nov. 1997) had a picture of my old friend Karl Baur. Karl worked for me at Chance Vought from the 1950s until his death in the 1960s. He was a great engineer and test pilot, and taught me a lot about German aviation.

After serving the Army Air Forces, the two-seat Me 262 in which Karl checked out the American pilots was kept outdoors on static display at Naval Air Station Willow Grove in Pennsylvania. But the weather took its toll, and in 1993 the aircraft was sent to Texas to be restored for indoor display. It is presently at the Texas Airplane Factory at Meacham Field in Fort Worth [see "Something Gold, Something New," Feb./Mar.

1995], where Herb Tischler is using it as a reference while building five flying 262 replicas. If Karl were alive, I know he would be with Herb, ready to check out the new owners.

—Joe E. Haynes
Dallas, Texas

Civilians Welcome

Along with the military folks, a small group of civilian pilots, of which I was one, flew in the Berlin Airlift ("Heroes Welcome," June/July 1998). We were employed by American Overseas Airline (later merged with Pan American). As I recall, we used a couple of American Airlines DC-4s and flew care packages and civilian and military VIPs. It was one of the finest learning experiences of my career.

—M.J. Sheehan
New Canaan, Connecticut

You Call This Paradise?

In 1946 I was "privileged" to spend 90 days on Kwajalein ("Catch a Falling Missile," Dec. 1997/Jan. 1998). As the yeoman for a Navy captain, my duties there were typing one letter a day to the captain's family and typing a weekly letter to the Navy reminding them that we were still there. Other than the long runway, a few Quonset huts, a small Red Cross shack (and a busy Red Cross girl), and a nightly movie in the outdoor arena, there was little on Kwajalein. I also remember that if you left a pair of shoes in the bottom of your locker, in several days they'd be covered with mold. And once I bought a sealed package of Buler pipe tobacco that turned out to be full of bugs.

—Roy W. Ranum
Silver Bay, Minnesota

Correction

June/July 1998 Cover: *Armageddon* is a Touchstone Pictures release.

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Man Versus Machine

In this corner, a Federal Express 727-200, weighing in at 140,000 pounds, with a thick rope attached to its nose gear. In the other, *Homo sapiens*, some 40 teams of 20 corporate and government employees, each team weighing in at, oh, say, 3,500 pounds. The objective: Pull the Boeing 12 feet in the shortest period of time. It's the first inch that's the hardest, says Boeing team member Carl Smith. "It's all momentum after that."

Each team has ponied up $1,000 to enter the sixth annual Plane Pull, held last May at Fed Ex's ramp at Dulles International Airport in northern Virginia. All proceeds, even the food vendors' take, benefit the Virginia Special Olympics.

"The competition gets fierce," says Special Olympics PR manager Laura Erera. The KR Industries contingent looks like a pro football team and puts so much muscle into the effort the athletes fail to wait for the official "Go!" and get the airplane up to taxi speed before being told to start over. After each pull, a mechanic in the cockpit stands on the brakes and the 727 bobs up and down on its nosegear. Another mechanic pushes the airplane back to the starting line with a tug.

Things are a little slow to get rolling on this hot, muggy morning. At noon the emcee announces, "We've done 14 pulls in 90 minutes. At this rate we oughtta be out of here by Tuesday, folks."

The National Transportation Safety Board turns in a nice, safe time of 8.34 seconds. The United Airlines Ground Power Unit, whose name alone holds promise, turns in 8.01. The Washington Air Route Traffic Control Center makes 8.4 seconds—"A lot faster than at work, huh, guys?" comes the taunt. Federal Express turns in an absolutely, positively mediocre time of 8.77. It's the beefeaters from the Prince William County Police Department, last year's winners, who get the tires fairly smoking at 6.42 seconds and hold on to their title. British Aerospace brings up the rear with 11.43. "Is that the official time?" says the announcer. "Sorry, it's just that I've never seen that many numbers." The 727 travels a total of about 1,300 feet, or you could say it gets one-quarter mile per 1,000 people.

At day's end there were a lot of strained backs, sunburns, and empty soda cans. There was also $50,000 in the kitty for the Virginia Special Olympics. Anyone care to join an *Air & Space* team next year?

—*Patricia Trenner*

CAROLINE SHEEN

Purdue's Crack Team

Like a cop sizing up loiterers for signs of criminal intent, professor Alten Grandt Jr. instinctively keeps an eye out for tiny precursors of impending structural failure. So when he noticed fatigue cracks in the handle of a university stapler, he called dibs. As soon as it broke he wanted it—for his collection.

When the stapler fell apart a month later, it joined a fractured hand exerciser, a busted hairbrush, a broken garlic press, a cracked toilet seat, and a snapped safety pin that once fastened diapers on Grandt's now-27-year-old son. "I call this environmentally assisted fatigue failure," says the aeronautics and astronautics professor. "Cyclic loading with every diaper change and sitting in a corrosive environment." Grandt employs these everyday objects as teaching tools at Purdue University in West Lafayette, Indiana. They share shelf space in his office with aviation artifacts like a cracked T-stiffener from the wing of a Lockheed T-33, a snapped centerline splice lug from a North American T-28, and samples from a recent study on metal fatigue and corrosion financed by the Air Force Office of Scientific Research. This ever-growing shrine to failure addresses a key aviation issue: keeping aircraft flying safely, as many reach their 30th, 35th, and even 45th birthdays.

Before coming to Purdue in 1979, Grandt worked for eight years at the Air Force Materials Laboratory at Wright-Patterson Air Force Base in Ohio—significantly, just when assumptions about fracture mechanics underwent a seismic shift. In 1969, an F-111 with less than 100 flight hours crashed on a routine mission, killing two pilots. An investigation revealed a forging defect in the structure that attached the wings to the fuselage. "Investigators went back, did the fatigue calculations, and said, 'Yeah, if you flew this airplane with this size flaw, the fatigue life would be about 90 hours—and it was," says Grandt, explaining that the accident helped metallurgists realize that

in trying to resist a failure mode known as buckling, they were sacrificing ductility, the material's ability to resist crack growth. Moreover, so-called rogue flaws—undetected manufacturing defects—were thereafter assumed present in the most unfavorable locations, sharpening attention on design redundancies such as crack-halting stringers, improved inspection techniques, and Grandt's area of study: how cracks grow and precipitate failure.

By creating tiny flaws in test samples of aircraft-grade aluminum alloy and then cycling the samples on laboratory machines, Grandt and his fellow Purdue investigators have become crack crack trackers. "We now have a much better understanding of the link-up and the coalescence of these small cracks, and good criteria for predicting how they will grow and link up," says Grandt, holding up a fragment of KC-135 fuselage, its tiny cracks barely visible. "We've polished the aluminum and know where to look and they're still hard to see," he says, alluding to the challenge of discovering such minute cracks over a real airplane's vast surfaces, many expanses of which are buried far from easy detection. This basic research, Grandt believes, should improve crack surveillance and the repair of aging aircraft as well as aid in design.

Grandt needs no reminder of the ever-present shadow of equipment failure. But if he did, he could glance elsewhere on his office shelves to yet another cracked piece of metal—this one a broken grip used to hold test specimens on a laboratory fatigue machine.

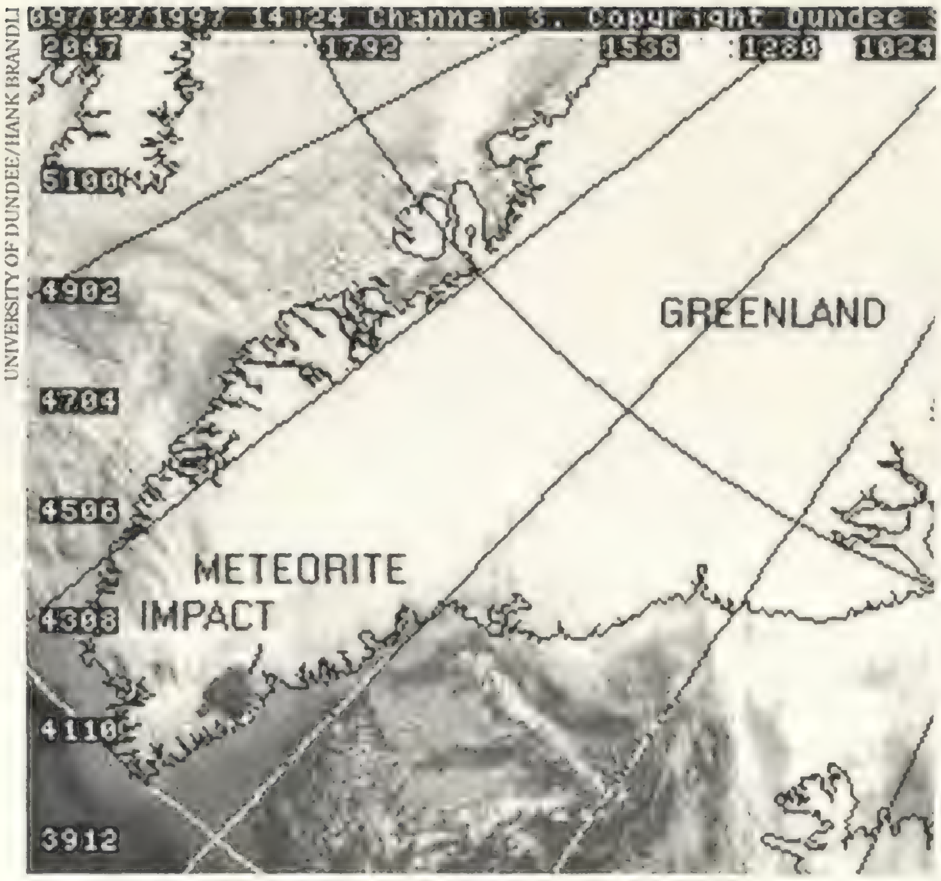
—John Grossmann

If a Meteor Falls in the Forest and No One Hears It...

Greenland has again been visited by a fiery extraterrestrial body. The latest meteor fell at 5:11 a.m. last December 9 in the southern part of the country, near Frederikshaab Isblink. The event was reminiscent of the arrival of the Kap York meteor, which fell during prehistoric times in Melville Bay, Sassivik, then broke into many smaller iron meteorites that totalled about 50 tons. Researchers are hoping that the newcomer will also yield a major scientific haul.

The effects of the meteor's impact are still a matter of intense debate, and for good reason: It's too difficult to look for the evidence during Greenland's long winter and spring, when snowstorms continually cover the region.

Certain initial reports proved to be inconclusive or erroneous: Seismic data from Norway that pointed to a small earthquake around the same time as the possible impact was later reinterpreted. An image of a dust plume taken by the NOAA-14 weather satellite 26 hours after the event has mostly been dismissed, as similar clouds have been observed over southern Greenland in the past—not to mention that satellite images taken right after the alleged impact showed nothing out of the ordinary.



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Most of the accepted evidence has been from more than 100 eyewitnesses along a 620-mile path from the Bay of Disko to just off the southeast coast of Greenland. Based on these reports—including footage from a parking lot video camera that caught the meteor flashing by—scientists at the Tycho Brahe Planetarium and the University of Denmark in Copenhagen have concluded that the meteor was probably a three-foot-diameter, one-ton rock that exploded at an altitude of 10 miles. It then broke into about 20 fragments, producing an airglow effect for another 13 miles before the chunks landed.

The approximate impact area was mapped on January 4 by the Danish Center for Remote Sensing using airborne synthetic aperture radar, but no feature could truly be called an impact crater. Because the meteor broke up in the atmosphere, the craters and fragments may be too small to show up in the radar images. Plus, according to Bjørn Franck Jørgensen, director of the Tycho Brahe Planetarium, "The firn [old snow] might have softened the collision, so that the craters are smaller—perhaps one to four meters—than normal for the speed and size of the fragments."

The best way to find impact craters and fragments will be a naked-eye search. According to Jørgensen, a small team representing the planetarium and the university will conduct a month-long search in August. The scientists hope the usual high winds blowing on the inland ice will clean off the snow, revealing blackened chunks of rock and icy impact craters.

The purported meteorite fall area is filled with glaciers, mountains, fjords, glacial meltwater, and crevasses, all of which could hide impact craters and meteorite fragments. "It is of course important to know exactly where to put the men on the ice," says Jørgensen. "If you are not careful, you may land on an island on the ice surrounded by fast-going rivers of water from the melting ice."

—Patricia Barnes-Svarney

UPDATE

New York Air Guard Flies South

The U.S. Navy has turned over its responsibilities for supporting the National Science Foundation's Antarctica program ("Flying at the Bottom of the World," Dec. 1989/Jan. 1990) to the New York Air National Guard's 109th Airlift Wing. The 109th, based in Schenectady, has operated in polar environments since 1975 and by February 1999 will be the only ski-equipped Hercules unit in the world. The Navy began supporting Antarctica operations in 1955 under Rear Admiral Richard Byrd's Operation Deep Freeze.

Stratovets

"He lost his balance, grabbed the emergency release, and dropped that bomb on Florence, South Carolina."

"Who was it who came back with part of a [refueling] boom stuck in the nose of his plane?"

"We had a crew chief, Henderson; he crawled in there [behind the nosegear] for a nap and nobody missed him before the plane took off. Pressurized? No, it wasn't pressurized in there. He must have had a very uncomfortable ride."

These are cold war stories from the

men who maintained and flew the Boeing B-47 Stratojet, the United States' first turbojet bomber. Last May, 120 B-47 vets and their guests held a first reunion in Omaha, Nebraska. Inevitably, they talked about the 1950s, when they were young and World War III seemed more likely than not. "You looked so good then," said Sigmund Alexander, president of the Stratojet Association. He put up a slide of a B-47 crew: three men in flight suits, with grins, flat bellies, and all their hair.

The association's goal is to revive the memory of an airplane now largely forgotten. Boeing started research on an all-jet medium bomber in 1943, but the company couldn't decide where to put the four engines. Initially they were placed in nacelles on the wings (Model 424); then they were moved inside the fuselage and fed by side intakes, with the exhaust departing through individual jet pipes just aft of the wing root on top of the fuselage (Model 432). Later, Boeing incorporated information from German research and swept the wings, moved the engine intake to the nose, and added two engines near the tail.

The final design, the Model 450, appeared in 1947 and had moved the engines into pods, a configuration that established the template for all large jet aircraft from that day forth. The B-47 is often called the single most radical design departure Boeing ever made, and it paid off in stellar performance: Its top speed of 608 mph made it the Air Force's fastest bomber. Before the airplane was retired in 1967, the service had bought over 2,000 of the type, most of them E Models. In recognition of the complexity of modern aircraft, it was the first bomber to receive a weapon system designation: 100A.

As its membership nears 1,000 after less than a year of organizing, the association seems firmly rooted. The B-47 vets agreed to meet again in 2000, a year that at mid-century not all of us really believed we'd live to see.

—*Daniel Ford*

Sport Jumps Don't Count

"What you have here," muses Master Chief Hal Picard, 67, describing a reunion of Navy test parachutists gathered at China Lake Naval Air Warfare Center in California, "is the last of the first and the first of the last." Picard would know. He was jumpmaster during the heyday of Navy parachute testing, starting in 1947, when the test facility was located at Naval Air Station El Centro. Jumps into the nearby Salton Sea facilitated perfection of devices such as the automatic canopy release, which was triggered by immersion in saltwater. In 1979, operations at El Centro were closed down and the unit was absorbed into the Naval Weapons Test Range at China Lake.

Picard stands figuratively at the center of naval test parachuting history. On a Friday night last May, he was at the center of a room ringed with memorabilia, hors d'oeuvres, and TV monitors filled with parachute canopies blossoming silently.

The 200-some former and current Navy test parachutists, manufacturers, Army and Air Force jumpers, and guests were assembled at China Lake for the first reunion since the 1960s. The "last of the first" Picard is talking about is Lieutenant Commander Edgar W. Smith. Smith, 83, was stationed at the Navy parachute school at Naval Air Station Lakehurst in New Jersey in 1944, when the Parachute Experimental Division was first established. In those days, aspiring parachute designers would show up on the Navy's doorstep with untried designs, hoping that the Navy would put the first jump on their canopies.

That direct approach soon gave way to a more cautious methodology, which is

why there have been only two fatalities out of the more than 60,000 test jumps. Master Chief Robert Hudson explained, "If we wanted to see if a system would deploy at a design limit of, say, 25,000 feet at 500 knots...we would start out at 10,000 feet and 200 knots and work our way up the graph." It's only the actual test jumps that establish a social seniority among the veterans, along with distinctions for type of canopy used and aircraft departed from. When asked for their experience level, several veterans concurred that sport jumps don't count.

On Saturday morning the veterans gathered in the parking lot and convoyed out to the current facility. In the loft, rigging tables covered with antique canopies and pictures of jumpers festooned with test gear provoked outbursts of recognition from the visitors. "This is just magic," Nancy Rodriguez gushed. Rodriguez's career as an official test parachutist began and ended on her 26th jump, which qualified her for the rating and broke her pelvis. That set off an effort to develop harnesses better suited to female pilots.

Later, the group reconvened at a park to enjoy a barbecue and compare canopy designs and tattoo techniques. The gathering was kicked off with a demonstration jump by current team members into the parking lot. Hal Picard felt that the current crop of test parachutists are probably the last of their breed. Parachute design has stabilized, and live jumping is now largely a matter of verifying minor modifications.

As the sun approached the Sierras, the group retired to Charlie's Lounge. Edgar Smith recalled the goal of Leslie Irvin, who invented the freefall, or ripcord, parachute. "He never thought of the parachute as a toy," Smith said. "The point was always to save lives."

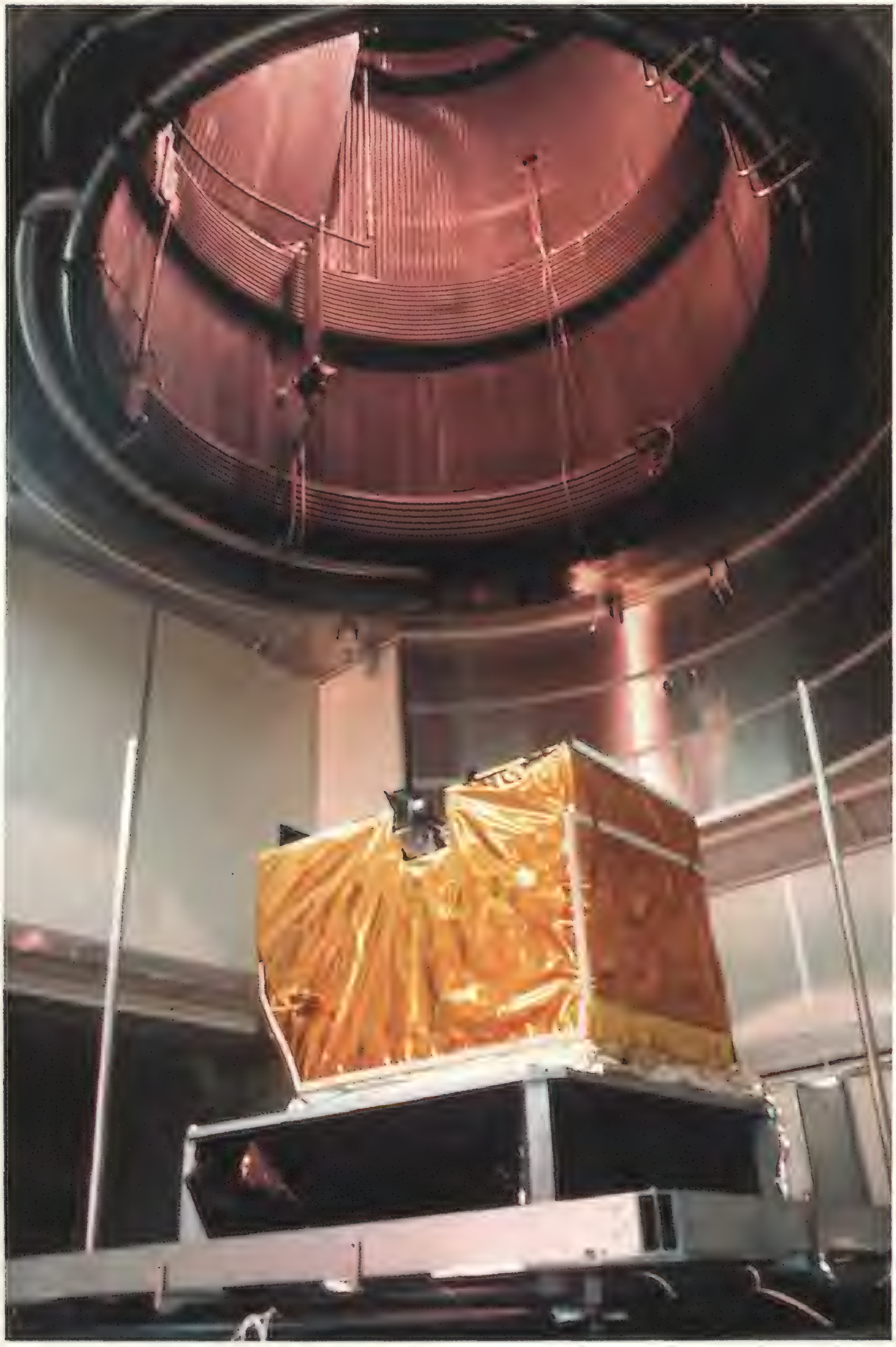
"I can't tell you how many lives we've saved," William Woodhouse, a veteran of Lakehurst, said as the reunion wound down. "Every time a Navy pilot has to punch out or some SEAL team member does an insertion, it works because they are using some piece of gear we tested or some procedure we developed."

—*Larry Lowe*

HARRY SCHMOLL

A Navy parachutist tested a tractor rocket system in 1966.

The Box



BARBARA GAITLEY

Early one morning in the spring of last year, I stood outside a room at NASA's Jet Propulsion Laboratory in Pasadena, California, and peered through a small window in a drab, gray metal door. I could see a box about the size of a steamer trunk standing on a pedestal in the center of the sparsely furnished room. The box was wrapped in gold foil and framed by a huge domed opening in the ceiling directly above it.

In profile, the box was not a simple rectangle. Its lower left corner was cut away at an angle and its top edge was notched. Heavy black cables coiled around the base. And across the gold wrapping, in a lighter shade of gold, I could make out the letters M I S R.

For nearly an hour I remained at the window, silently bidding the box goodbye and wishing it a safe journey. The box goes by the name Multiangle Imaging SpectroRadiometer—328 pounds of wires, lenses, silicon wafers, and metal supports in a compact package. MISR is one of five instruments that make up the scientific core of NASA's first Earth Observing System satellite, EOS-AM. If all goes well, the satellite will be launched into polar orbit around Earth late this year.

As I gazed through the window, I saw more than MISR dominating the room. I saw seven years of effort, involving close to 100 pairs of hands. I saw the long nights of figuring, wondering, machining, and soldering. Hidden by the gold wrapper were nine high-performance solid state cameras, each pointed in a precisely determined direction. Autonomous systems supplied each with power, heating, and cooling. And there were separate data streams to control each camera, monitor its vital signs, and process the data each produces.

I was just an awed spectator to this engineering achievement. But what my

In May 1997, the Multiangle Imaging SpectroRadiometer—MISR for short—was tested in the thermal chamber of JPL's Space Simulator Facility.

colleagues on the MISR science team and I hope to learn about Earth's climate from this instrument should fill our research notebooks for the next decade. We had spent years creating and studying computer simulations, trying to imagine what it would be like to see images from MISR. Now I stood face to face with the instrument itself. The hardware commanded my attention with a power unmatched by all my graphs and equations.

The scent of fresh data in the air brought to mind the reasons so many people had gone to so much trouble to build MISR. Nothing like it has ever flown in space. From about 440 miles above the surface, it will measure light reflected from Earth at nine angles.

If Earth were a movie screen, there would be no need for MISR. Movie screens are made of a material that reflects light nearly equally in all directions, so the movie looks equally sharp and bright for people sitting in all sections of the theater.

But Earth is more complicated: Its surface, the clouds, even tiny particles floating in the air all reflect light differently when viewed at different angles. And the manner in which sunlight is scattered by forests, deserts, snow- and ice-covered surfaces, clouds, soot, and other by-products of industry has a measurable impact on our climate.

Most satellite instruments look only straight down or toward the edge of the planet. To fully understand Earth's climate and determine how it may be changing, we need to know how much sunlight is scattered under natural conditions. As MISR orbits overhead, each piece of Earth's surface will be imaged by all nine cameras, in each of four wavelengths (blue, green, red, and near-infrared).

My colleagues and I dream of viewing the life cycles of atmospheric particles, from their sources in arid regions, volcanic areas, and industrial sites to the point where they rain out of the air somewhere downwind. We hope to monitor changes in forest canopies and land cover over the entire planet for at least six years, watching deserts advance, glaciers recede, and grasslands adjust to temperature and rainfall variations from year to year. Using multi-angle "hyper-stereo" views, we also plan to measure the height and texture of clouds.

But such information will not pop out of the MISR measurements. We must tease each bit of knowledge from the tangle of simultaneous surface and atmospheric reflections that emanates from Earth toward space. I specialize in atmospheric particles; for 15 years before joining the MISR team I studied dust storms and clouds in the atmosphere of Mars. Returning to Earth, I was confronted with the demands of climate modelers, whose predictions affect government policies on energy and land use. To account for the effect of dust, smoke, and haze, climate modelers need to know the brightness as well as the abundance of atmospheric particles over the entire globe. No one had ever placed such exacting demands on our studies of Mars. And no one has found a reliable way to measure from space the brightness of particles in a thin haze floating above a surface whose ability to reflect sunlight is itself poorly known.


JPL

The scientific core of the instrument, the MISR optical bench contains cameras and calibration equipment.

Multi-angle data from MISR could help. The amount of light that airborne particles scatter depends on the particles' size, shape, and composition. Our computer simulations show that when viewing commonly occurring particles under favorable conditions, MISR can distinguish spherical from non-spherical particles, and can identify small, medium, and large sizes, as well as dark and light coloration. (I call this the underwear model: small, medium, and large; dirty and clean.) So MISR could give us far more information about particles than anyone has derived from satellites before—enough to track air masses containing different particle types as they move around the planet.

To meet the climate modelers' demands, we are working with colleagues who study atmospheric particles from the ground. These field observers measure particle brightness and other properties within air masses. But because they must carry their equipment to each observation site, they can visit only a few locations. By combining ground measurements with MISR data, we should be able to complete the global picture.

But at this point we have no MISR data—only hopes. Our plans hinge on the success of an instrument flying in space. MISR will be a distant speck, as far away from Earth's surface as Boston is from Washington, D.C., circling the planet every 99 minutes over the poles. The instrument has to operate flawlessly, or nearly so, for the duration of its flight; there will be no way to repair it after launch. Its gears must mesh, its optics must see clearly, its computers must process commands and measurements reliably. Building in such high dependability was expensive. Like most spaceflight instruments, the box cost many times its weight in gold.

While the instrument is still on Earth, great pains have been taken to prepare it for life in space. Built and tested at JPL, MISR is a package of "right answers"—connections, mechanisms, and programs that were meticulously checked and calibrated. The morning I looked through the window at the instrument, it had just passed its final examination. The box was graduating. It had been shaken to accelerations of up to 40 Gs. Then for nearly 13 days it had been sealed in an eight-foot chamber with the air pumped out to simulate the vacuum of space. To mimic conditions in flight, the instrument had been chilled to -13 degrees Fahrenheit, then heated to 104. After all that, it still worked.

MISR was ready to orbit Earth. The instrument was shipped from Pasadena to a Lockheed Martin facility in Valley Forge, Pennsylvania. There it was bolted onto the EOS spacecraft and retested, along with the other four instruments and the spacecraft itself. Later this year, EOS-AM will be moved back across the country, to Vandenberg Air Force Base in California, for a December launch aboard an Atlas 2AS rocket.

My colleagues and I wait for launch, counting the weeks, tweaking our data-handling procedures, scrutinizing the computer programs we have written to analyze MISR measurements, and biting our nails. What matters most to us now is: Will everything work?

Space science is for the hopeful.

—Ralph Kahn

Vintage Skunk

Sheets of fabric, brittle with dope and loosely rolled, sit on a metal shelf. Dusty curls of cowling lie on the concrete floor. Scads of metal fittings fill a row of paper cups, and pieces of an 85-horsepower engine—crankcase, cylinder heads, and pistons—rest on a worn worktable. Seemingly everywhere are rags, masking tape, coffee cans, sponges, and assorted tools, but standing out showily amid the tangled array is a sporty little red and white biplane—a Pitts Special S-1C with the ignoble name *Little Stinker.*

Renowned airplane designer Curtis Pitts hand-built *Little Stinker* in 1945. The second Pitts Special ever constructed, *Little Stinker* arose from Pitts' desire to build an airplane designed for aerobatic flight. Though Pitts lacked a formal aeronautical education, his lightweight, short-winged biplane design was literally a winner: In 1948 a petite young woman named Betty Skelton (now Betty Skelton Frankman) bought *Little Stinker* and flew it to victory in the 1949 and 1950 Feminine International Aerobatic Championships in Miami, Florida. Frankman's triumphs were just the beginning of a 50-year stretch of pilots winning aerobatic meets all over the world with Pitts Specials.

ERIC LONG

COURTESY BETTY SKELTON FRANKMAN

Aerobatic pilot Betty Skelton Frankman, often accompanied by her dog, Little Tinker, logged many hours aboard Little Stinker, *a Pitts Special now being restored by (top, left to right) Roger Guest, George Rousseau, Joe Fichera, Bob Dawson, and Cindy Rousseau.*

Donated by Frankman to the National Air and Space Museum in 1985, *Little Stinker* has been under the ministrations of a group of restoration volunteers at the Museum's Paul E. Garber Restoration, Preservation and Storage Facility in Suitland, Maryland. For the last two years, the five-member team, headed by Joe Fichera, has been working on the Pitts every Thursday. Fichera, who was a Garber restorer for 15 years before retiring in 1983, figures that he and the others in his group—Bob Dawson, Roger Guest, and George and Cindy Rousseau—will be finished by the end of the year. Dorothy Cochrane, *Little Stinker*'s curator, couldn't be more pleased. "It was just great to have them all come along like that and offer their time," says Cochrane. "They've donated many hours of wonderful expertise."

Fichera, a pilot who started working at the Lawrence, Massachusetts airport at age 13 in exchange for flying time, says that *Little Stinker*'s cockpit and airframe were in good condition. "All we did was clean up a few rusty spots, revarnished the existing wood," he says. "Everything was cleaned and painted and preserved." What *Little Stinker* needed most was a new fabric covering over its metal and spruce airframe—a refurbishment that would help return the biplane to the dashing appearance that had first drawn Frankman to it half a century ago.

The pilot remembers well the first time she saw her beloved Pitts. It was 1948, and she was flying her 1929 Great Lakes biplane into Miami for an aerobatic meet. "I was in the traffic pattern—just arriving in Miami," Frankman recalls. "I looked down and saw this little tiny airplane sitting there with a crowd gathered all

around it. And I thought it was the cutest thing I'd ever seen. I landed and I went running over to where the crowd was and got up to the front and looked the airplane over. I asked the man standing there with it if I could sit in it. He said, 'No, we don't let anybody sit in it.' I looked at it a while longer, and I thought, *Someday I'm going to have that airplane.*"

The Pitts belonged to airshow pilot and promoter Jess Bristow. "Every time I'd see it, it just killed me," says Frankman. Finally, over the phone, Bristow agreed to sell it to her. She named the aircraft *Little Stinker Too,* since her Great Lakes was named *Little Stinker* (and had a skunk painted on both sides of the fuselage). Frankman got the idea for the name from the mechanics who had assembled the Great Lakes. Not wanting to swear in her presence, they instead exclaimed "Oh, you stinker!" After a mechanic cracked up the Great Lakes on the way home from the Cleveland Air Races, Frankman dropped the "Too" on the Pitts.

Fichera's team has yet to paint the skunk figure on both sides of *Little Stinker*'s fuselage (that will come toward the end of the restoration). What they have done is cover the airframe with new cotton fabric, the most tedious part of which was sewing the fabric onto the wings and control surfaces in a process known as rib-stitching. The job required two team members to slowly weave a 12-inch needle, threaded with linen cord, up and down along the ribs of each part—individually knotting each stitch. Fichera was on leave during the rib-stitching of the rudder, elevators, and ailerons, and when he returned, he felt that the results were not as good as they could be. So the team gamely undid the stitching and started anew—with Fichera looking on.

When the cotton covering was firmly in place, the volunteers used spray guns to apply about a dozen layers of dope, which strengthens and waterproofs fabric. They applied a clear layer of dope mixed with aluminum powder to block the sun's ultraviolet radiation, then painted on additional layers mixed with the red, white, and black pigments required by the paint scheme. The overall effect is stunning: smooth, taut cloth shiny with dope and not a wrinkle or scratch to be found. "You could hit that fabric with your fist right now and it wouldn't break," says Fichera.

Since *Little Stinker* arrived at the Garber facility without an engine, Cochrane spent several years searching for a historically accurate replacement: either a Continental C-85 or C-90. The Museum was forced to purchase an engine—a C-85—when she could not find a suitable donation. "Both engines are hard to get because they're still being used," says the curator. "So people don't want to give them up." As for the propeller, Frankman had given it away. "It was under the bed at this friend's house," says Cochrane. "And it was just sitting there. And Betty said, 'Can I have this back? They need it at the Smithsonian.' And they said 'Sure.' "

After Fichera and company are done restoring *Little Stinker*, the airplane will probably be exhibited at Garber; later it may move to the Museum or to the new Dulles Center in Virginia. Though Frankman is "thrilled" at the thought of the Smithsonian displaying her airplane, it was not without a touch of sadness that she let go of *Little Stinker.* After all, she enjoyed flying it more than any other airplane, and never more than on the long journeys between performances at airshows and competitions. "As you were flying along, you would look down at that tiny wing and wonder how in the world it could be an airplane," says Frankman. "It was a real experience just to sit in the airplane and fly it cross-country."

—*Diane Tedeschi*

VISITORS

NASA DRYDEN

There aren't many people who can walk into the National Air and Space Museum and say they have flown three of the aircraft on display. William H. Dana is one of them. Recently retired as the chief engineer of NASA's Dryden Flight Research Center in California, Dana flew the Lockheed F-104A Starfighter, the Northrop M2-F3 lifting body, and the North American X-15 throughout the 1960s. On May 21, Dana, a modest, soft-spoken man, stood before an audience in the Museum's Langley theater and talked about his 16 test flights in the hypersonic X-15, a rocket-powered research vehicle that took him to an altitude of 310,000 feet—the fringes of space. After reentering the atmosphere, the X-15 pilot had to make an unpowered glide back to Earth, and though the short-winged X-15 was a low-lift aircraft, Dana reported that it proved easy to land. More demanding, said Dana, was the 4-G vertical acceleration through the atmosphere, during which the pilot would lose sight of the horizon.

Museum Calendar

Except where noted, no tickets or reservations are required. To find out more, call Smithsonian Information at (202) 357-2700; TTY (202) 357-1729.

August 29 "Exploring the Milky Way." Join Jim O'Leary, director of the Davis Planetarium at the Maryland Science Center in Baltimore, for a look at how scientists create images of our galaxy. O'Leary will also highlight the coming attractions of the September night sky. Einstein Planetarium, 6 p.m.

September 14 A new exhibit, "¡Arriba! The History of Flight in Mexico, Central America, South America, and the Caribbean," opens in the Air Transport gallery. The exhibit features maps showing the growth of airline development in Latin America, photographs of such aviators as Alberto Santos-Dumont and Jorge Chavez, and models of the aircraft they flew.

The President's Plane Is Missing

For Carlton Fisk it was his home run for the Boston Red Sox in the sixth game of the 1975 World Series. For Joseph Heller it was *Catch-22*. Out of long and distinguished careers, each will be remembered most vividly for one thing alone. It's the same for SAM 26000, a presidential aircraft that retired last April. In 36 years and 13,000 flight hours, the Boeing 707 served eight U.S. presidents. But what placed the airplane most firmly in the nation's memory was a single mission: SAM 26000 flew John F. Kennedy to Dallas and brought his body back to Washington.

Joe Chappell was flight engineer that day and Paul Glynn was flight steward. Now retired, both chief master sergeants recalled how the Dallas stop veered suddenly from the festive to the ghastly. "The hearse pulled right up to our wingtip," Chappell says. A bulkhead and two rows of seats were removed so the casket could be placed in the cabin rather than the cargo hold. Standing once more in the aisle where he had worked for 10 years, Glynn described the poignant sight of Lyndon Johnson helping to carry the casket of his predecessor into the aircraft.

During Johnson's brief swearing-in ceremony, Glynn steadied the Air Force photographer who climbed high on a couch to get that famous shot of the crowded, anguished scene. Throughout the flight to Washington, Mrs. Kennedy sat quietly beside her husband, according to Glynn, still wearing her bloodied pink suit. Thirty years later, it was her casket being transported to Washington on the same aircraft for burial at the Kennedy gravesite at Arlington National Cemetery.

At the U.S. Air Force Museum near Dayton, Ohio, 26000 (known in Air Force parlance as a VC-137) has taken its place alongside Roosevelt's *Sacred Cow*, Truman's *Independence*, and Eisenhower's *Columbine III*. If enough of the original furnishings can be found, 26000 may be restored to its Kennedy-era look.

Any Air Force aircraft flying the president carries the radio call sign Air Force One. SAM (for Special Air Missions) 26000 was the first jet in the military executive fleet specifically built for presidential use and the first that had been earmarked for the chief executive from its first day in service. From 1962 to 1972, 26000 was the primary presidential aircraft. It shifted to backup duty when a newer 707 was added to the fleet. When two 747s took over in 1990, 26000 continued to carry other VIPs. Over its years of service, it flew Kennedy to Berlin and Ireland, Nixon to China, Kissinger to secret Vietnam peace talks, Congressional leaders back to Washington during the Cuban Missile Crisis, and Queen Elizabeth II on a West Coast tour.

Throughout that long career, the interior of 26000 remained a work in progress. Incoming administrations would change the decorations, even the floor plan. Like earlier versions, the current configuration is functional, far from lavish. In most compartments, the seating is standard business class, two abreast. The president has a stateroom with adjoining lounge and private lavatory. Meetings can be held in that suite or couches can be converted into beds. Further aft is a staff room with office equipment. There are two galleys and a communications center.

Land a spot on that 18-member crew and you had a view of presidents and their families available to few other Americans. "They were all good eaters," Charlie Palmer says of the presidents he served from 1973 to 1986. "But President Reagan would eat lighter when Mrs. Reagan was on board. She looked after him." Nixon's unvarying lunch: "A canned-pineapple ring and a scoop of cottage cheese, with no lettuce, no garnish of any sort, no decoration." Reagan did want lots of jelly beans around, actually Jelly Bellies, and for Carter, naturally, it was peanuts, dry roasted.

The presidential stateroom has a sound system. As he recovered from gallbladder surgery and his presidency lost support during the Vietnam War, LBJ listened to one song repeatedly: "Raindrops Keep Fallin' On My Head." "I guess he figured everything was coming down on him," Paul Glynn says. "We were so sorry to be hearing that song over and over."

Vice President Al Gore was the last dignitary to fly aboard 26000. Air Force officials cited increasing maintenance costs as the reason for removing the venerable Boeing from service and eventually also its sister 707. They are being replaced by a pair of 757s. But there is no quiet retirement in store for 26000. It is hosting far more crowds now than it ever did in operation. "It's in good hands," says Air Force museum staffer Denise Bollinger. "We're like a bunch of beaming parents."

—*Lester A. Reingold*

LESTER A. REINGOLD

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by Craig Mellow

Photographs by Nikolai Ignatiev/ Network Photographers

This ain't Cape Canaveral, pal. The place is what passes for an airport in Kustanai, Kazakhstan; the date, February 19, 1998. The temperature is –13 degrees Fahrenheit, cold enough to hurt your face the second you turn toward the wind. Cold enough for men to freeze to death if, say, rescuers can't find the space capsule that just brought them back to Earth.

A motley collection of two dozen Russian space professionals and aficionados—scientists, doctors, cameramen, parliamentary staffers—cling to the edge of an air strip despite the weather. They stare off into the board-flat central Asian steppe, as if a determined eye could cover the 250 miles to where three cosmonauts already should have touched down. General Yuri Glazkov, a spaceflight veteran himself who looks like a fireplug and sounds like a bullhorn, is rallying the faithful in his own inimitable fashion. "Whoever is cold didn't drink enough," he bellows. Beneath the bluster, though, Glazkov, deputy director of the Gagarin Cosmonaut Training Center, is worried about his men.

Here at Kustanai the afternoon sun is brilliant. But at the landing site a blizzard is raging. Wind gusts across the naked steppe at up to 60 mph. Visibility is virtually zero. This is how Mother Earth has seen fit to welcome back three space travelers—Russians Anatoly Solovyev and Pavel Vinogradov and Frenchman Leopold Eyharts—after a long, stressful repair mission on the Mir space station. Normally, 30 or 40 people would be on hand to greet them at the landing site. But the weather is so treacherous that only one helicopter with essential crew members has been dispatched from Kustanai for the rescue. All that the rest of us can do is wait.

It has been 27 years since Russia lost a cosmonaut returning from orbit—June 1971, when rescuers opened the Soyuz 11 capsule to find its three-man

Soyuz TM-24 returns to Kazakhstan in March 1997, charring the snow-covered steppe with its braking rockets.

SOVFOTO

Aiming for Arkalyk

NASA astronauts land on a runway, in the Florida sunshine, about an hour's drive from Disney World. Cosmonauts come home the hard way.

crew dead, victims of a blown valve that vented their oxygen supply to space. Over a decade has passed since a returning capsule missed its target by more than a dozen miles. Soyuz landings have become like U.S. space shuttle landings—routine and for the most part trouble-free.

Yet today is the nastiest landing weather anyone on hand can remember. No one is breathing easy until Solovyev and Vinogradov—Tolya and Pasha, as they are known within this intimate group—and their French companion are home in one piece.

Once a whole country would have shared in the suspense. But gone are the days when Soviet space landings drew crowds of air marshals and ministers, when the nation was glued to the radio for news, when swooning schoolgirls begged handsome cosmonauts for autographs. The small group of diehards who set forth yesterday from the cosmonauts' home base in Star City outside Moscow has more the feel of a community picnic—one mistakenly planned for the height of a hurricane.

Reaching Kustanai has been a minor adventure in itself. We non-essential personnel (the rescue team flew ahead separately) made the journey in the cosmonaut retrieval airplane, a custom-equipped Tupolev Tu-154 with railcar-style sleeping compartments replacing half the seats. On the morning of our departure from Star City's Chkalovskoye military airport, Mike Baker, the four-time U.S. shuttle astronaut who now heads NASA's liaison office for human spaceflight in Russia, drove up to the runway late, grinning excessively for such an early hour. "These people are crazy," he muttered to Herve Stevenin, director of crew training for the French space agency. "We were already drinking vodka in the car over here."

Down in Kazakhstan the tempest had already begun, shutting down the airport at Kustanai, a two-and-a-half-hour flight to the southeast. We briefly placed our hope in two airfields farther south, near Baikonur, the cosmonauts' launch site. But neither location, as it turned out, had electricity. The local Kazakh utility, unsentimental about past greatness, had cut them off for non-payment.

With that news Glazkov left in an atmospheric huff and was gone for two hours. After "titanic efforts," he explained on his return, he had managed to cadge a landing slot at Karaganda, a heavy industrial center an hour east of Kustanai. "At least we know a hotel there," enthused Igor Rudyayev, the cosmonaut training center's PR man for the journey. "Sometimes we have to sleep in the plane."

By noon the next day, just three hours before the cosmonauts were due to land, Kustanai finally gave arrival clearance, and our airplane revved toward the Karaganda runway for takeoff. Ex-Soviet friendship broke down again at this point, though. Airport officials boarded the craft demanding a $400 landing fee. Glazkov let forth a predictable stream of barracks Russian, but after an hour of dickering he paid up.

So it goes when your landing site is 1,100 miles from home, located in what is now, but didn't used to be, another country.

Kazakh policemen stay warm inside the airport at Kustanai while waiting for the rescue helicopter's return.

The drama of American spaceflight, at least to those watching the Apollo moon landings on TV, was always packed into the launch, with its pillars of fire and taut voiceover from mission control. Astronauts' return to Earth was a happy-ending anticlimax. On splashdown days the ocean always seemed calm and sun-speckled, the Navy's recovery ships (we never used the word "rescue") an easy distance from the reentry capsule.

The Soviet Union, however, had no tropical coast. The Caspian Sea is not far, in Soviet terms, from the Baikonur launch facility, and is at roughly the same latitude. But the Caspian is a stormy, temperamental body of water, densely packed with fishing boats. So landing gear and procedures had to be designed for land.

The target zone selected was near the town of Arkalyk, about 150 miles north of Baikonur. Yuri Gagarin and others who soloed in the early-1960s Vostok vehicle simply ejected on the way down, returning to Earth like paratroopers who happened to take the pilot's seat with them. But when Soviet designers switched to the Soyuz design in the mid-'60s, hoping to beat Apollo to the moon, they added a reentry capsule with room for three cosmonauts.

Steppe has less give in it than ocean. So along with parachutes to slow the capsule's descent through the atmosphere, Soyuz engineers added four retrorockets, which ignite just above the ground like a fiery set of brakes. Even with specially molded, spring-backed seats to cushion the impact, cosmonauts get a jolt on landing similar to a skydiver's, except that they're strapped in their chairs and have nowhere to roll. They take it all in the back and kidneys.

After that jarring landing, they need to be found and brought back. Which

Yuri Glazkov (foreground, second from left), deputy head of the cosmonaut training center, orchestrates the final preparations for the flight back to Moscow. First, though, Mir commander Anatoly Solovyev (below) gets help readjusting to gravity.

is why a team of experienced rescuers arrived in Kustanai ahead of us to work out the details of who should go retrieve the Soyuz crew and how. Normally, Russia's Federal Search and Rescue Service sends three Mil Mi-8 helicopters to do the job, one for each cosmonaut. Normally they have a 30- to 40-minute flight from Arkalyk. But today is not normal, and they'll be flying out of Kustanai, two hours away. Rescue service officials decide to send only one helicopter (deep-sixing our own plan to tag along with the rescue party). There is only one pilot the officials trust to fly blind through the storm, then find a small spaceship somewhere within a 25-mile-diameter circle. His name is Anatoly Mikhalishev.

With him he takes a 10-member crew headed by the training center's chief physician, Oleg Fyodorov. Three of the 10 will not come back, at least not immediately. They have to yield their places to the cosmonauts, then wait in the thin cover of the vacated space capsule until a back-up chopper gets through to pick them up. The rescuers are not particularly fazed, though. This is the same A-team that puts cosmonauts (and a few lucky American astronauts) through three-day survival training at Tiksi on the shores of the Arctic Ocean. In the off-season they test how long trainees can last in the Turkmenistan desert with two liters of water. Let Mikhalishev find the spacecraft; they'll stay out as long as they need to.

Russian mission control, which goes by the acronym TsUP, has been directing this spaceflight from back in Moscow for the entire six months that Solovyev and Vinogradov have been in orbit. Yet once the Soyuz splits from Mir and begins plummeting to Earth, the brain trust at TsUP can do little but cross their fingers. Voice contact ceases due to ionization of the surrounding air as the capsule falls at terrifying speed from a 186-mile-high orbit to an altitude of only six miles in about 20 minutes. (French cosmonaut Eyharts reported later that he found the plunge "particularly exciting.") For TsUP controllers, who know that death can lurk beyond that wall of silence, it remains a trial.

At 31,000 feet, the altitude of commercial jet flights, the first two in a sequence of four braking parachutes pop open. By 24,000 feet the Soyuz has slowed enough to open its main parachute, a behemoth that when fully unfurled covers 10,000 square feet—almost half

the area of a football field. TsUP can hear the cosmonauts again during this phase of the descent. But responsibility for tracking them, by ancient bureaucratic custom, passes to rescue service controllers in Kazakhstan. On calm days, their radar locates the capsule fairly accurately. But when high winds are buffeting the capsule during its parachute descent, as they are today, the radar has trouble holding the track. The Mi-8 pilot must then use his own wits and eyesight.

Mikhalishev had the Soyuz capsule on his helicopter's onboard radar until about 13,000 feet, then lost the signal. He was guided now only by squawks on the radio from mission commander Solovyev. Tolya is a proven quantity, returning from his fifth mission on Mir, where a month earlier he celebrated his 50th birthday. He has right stuff beyond question, having seen more open cosmos than any other Earth inhabitant over the course of seven spacewalks totalling some 60 hours. On the other hand, he has always taken landings hard, emerging from the capsule doubled over by motion sickness.

During the last few moments of descent Mikhalishev strained to make visual contact and timed his own landing to coincide with touchdown of the spacecraft. Suddenly the Mi-8 had landed in the deep snow, with the Soyuz capsule right next to it. How it happened none of the rest of the crew could say. "All I could see was frost covering the window," Fyodorov recalled later. "Visibility was nil. This was just the art of the pilot, a very experienced pilot."

After half a year on Mir and more than three hours in their womb-like reentry vehicle, alighting cosmonauts generally welcome a little fresh Earth air, no matter how chilly. Service etiquette dictates that when rescuers pop the hatch, the returning space traveler's first words be "*Vsyo normalno*"—everything's fine. Also *de rigueur* is an attempt to climb down the ladder from the hatchway unaided. Thanks to Mir's three-hour daily exercise regime, many cosmonauts do return in surprisingly good shape. The legendary example is Anatoly Artsebarsky, who after a six-month mission in 1991 remained standing through an interminable reception in his honor back in Arkalyk.

Solovyev greets a well-wisher on the airplane home, while Pavel Vinogradov (below) rests in his cabin. The worst thing about Mir, says Vinogradov, was the lack of variety in conversations with the ground.

After this show of grit, cosmonauts are ushered into folding chairs where, weather permitting, they whip off their space helmets and enjoy the Kazakh breeze. Doctors take pulses and blood pressure, and the reentrants are offered tea. Sometimes they hold impromptu press conferences.

Meanwhile rescuers are blowing up a small inflatable field hospital, complete with an operating theater, which is ready within ten minutes of touchdown. The cosmonauts are brought into the heated interior and removed from their spacesuits. Clothes sweated through during the high-temperature reentry also are changed. Next follows an EKG, blood tests, and a rigorous hour-long physical. A surgical team stands by, but its services have never been needed.

This is how it happens usually. But today is not much of a day for sipping tea or pitching tents. Three stretchers on the helicopter floor will have to do. Mikhalishev keeps the blades churning while Fyodorov's team rushes through pared-down physicals. Half an hour later they're in the air, headed back toward civilization.

Meanwhile, in Kustanai, it's time for lunch. Herve Stevenin, the French space official, looks forlornly at a sophisticated incubator he'd hoped to take to the landing site to hold six salamanders who've been busily laying eggs on board Mir. He fears the reptiles will freeze before he sees them again. Glazkov and his Star City back-benchers have long ago drifted despondently from the runway, their own hopes of reaching the landing site dashed.

Yet certain courtesies must be observed. The political elite of Kustanai—a featureless cinderblock settlement of 300,000 people thrown up, like nearly everything else in northern Kazakhstan, to exploit a nearby metals seam—have turned out in their finery. A Jeep Cherokee awaits the most important Moscow visitors; a sharp new touring bus will transport the lower-downs, like doctors and journalists. The pasty official toastmastering the less exclusive banquet is the picture of provincial ex-Soviet

Kazakh folk dancers await the returning heroes inside the Kustanai airport. After only three weeks in space, French guest cosmonaut Leopold Eyharts (below) is in comparatively good shape on the flight back.

sleaze, and is obsessed with the idea of touring the local chocolate factory. But after four or five vodkas and a steaming bowl of borscht, he kind of grows on everybody.

The drama and danger of a space landing start to recede from our thoughts. Yet some Russian space veterans can recall past disasters only too well. Between 1967 and 1976 Soyuz spacecraft experienced five serious accidents. Four of them involved failures during reentry or landing. Two were fatal.

Disaster struck on the very first Soyuz flight—April 23, 1967—and old-timers still curse the apparatchiks for it. The record strongly suggests that the new vehicle was not ready for flight. That was what U.S. intelligence concluded, based on the mistaken premise that the Soyuz had undergone four test launches. In fact there had been only three.

But 1967 was the 50th anniversary of the October Revolution, and the Party wanted something to boast about on May Day. So Vladimir Komarov was sent up for a three-day mission. Trouble began when one of the vehicle's solar arrays failed to open. Several key systems failed for lack of power, including the one that navigated the reentry. Komarov managed to find the right trajectory manually and landed on target. But rescuers found his ship on fire, with onlookers from the nearby village of Karabatuk frantically throwing dirt on it. Komarov's charred bones were later found inside, along with a main parachute that had failed to open.

This was Russian spaceflight's grisliest moment until Soyuz 11 returned to Earth in June 1971. Mission control had no inkling of trouble during the capsule's descent, and a hero's welcome awaited Georgi Dobrovolsky, Vladislav Volkov, and Viktor Patsayev, the first crew to live on the Salyut space station. Popping the hatch, rescuers found the cosmonauts in place and untouched, but dead. The best postmortem guess was that an air vent meant to open well within the atmosphere (at 13,000 feet) opened instead in space when the reentry capsule separated from the Soyuz orbital module. Death by pulmonary embolism took less than a minute.

In between the fatal accidents came Boris Volinov's miraculous survival of the 1969 Soyuz 5 landing. Leaving orbit, his small reentry capsule failed to disengage from the rest of the Soyuz

vehicle. Volinov hurtled toward Earth with a flaming three-ton piece of excess baggage on his back. "They say that in TsUP someone started passing a hat for funeral money," writes Mikhail Rebrov, a Russian military journalist who himself trained as a cosmonaut in the 1960s. Fortunately the capsule finally disengaged, and the parachutes opened. But the impact broke all of Volinov's upper teeth at the roots.

That detail, of course, was hidden from the public. TASS reported only that "A unique experiment was concluded. The ship landed in the designated region." An old-school flier who put duty first, Volinov even came out to meet the official press as he flew back to Moscow, holding his hand over his face to hide the injuries. "Takeoff proceeded normally. The technology worked reliably," he told them, then politely signed a few autographs. Doctors told Volinov his cosmonaut days were over. Seven years later on Soyuz 21, he proved them wrong.

But the landing that best revealed cosmonaut character was on Soyuz 18A in April 1975. Vasily Lazarev and Oleg Makarov had risen to an altitude of 120 miles when their R-7 booster malfunctioned, prompting an abort. Instead of soaring into orbit, the pair plummeted back to Earth on a trajectory that raised their G-level above 20. Test pilots' kidneys have ruptured at 15 Gs.

Twenty-one minutes after takeoff the cosmonauts' capsule was hanging by its enormous parachute from a tree in what turned out to be the Altai mountains of southern Siberia, near the Mongolian border. April is still winter in Altai. It was snowing hard and getting dark. The cosmonauts leapt out into waist-deep snow and divined that their ship was at the edge of a precipice, its weight slowly snapping the pine branches that held it. Another few yards and they would have fallen to certain death. Lazarev and Makarov whipped off their spacesuits and used them to prop up the precious capsule, facing the freezing night dressed only in track suits. Rescuers flew overhead and made radio contact, but were unable to land in the stormy night. Luckily, the next morning was clear enough for a helicopter to hover above the trees and drop a ladder to the cosmonauts. The reentry vehicle survived to fly again.

Communist bureaucracy showed its face most clearly after the last great Soyuz landing mishap, which happened in October 1976. This time Soyuz 23 strayed off course and landed in Kazakhstan's Lake Tengiz. It was another night when rescue helicopters were no match for the Soviet elements—temperatures of seven below zero, the lake enveloped in thick fog. The reentry capsule floated, but the sinking parachute turned it upside down, its exit hatch sunk in the half-frozen water. Ice quickly covered the ship's air vent, leaving cosmonauts Vyacheslav Zudov and Valery Rozhdestvensky depending on a backup oxygen supply to stay alive.

Suddenly there was a knock at the cabin window. One of the rescuers, a Captain Chernyavsky, had taken up the search himself in a rubber raft. How he found the spacecraft three miles from shore in that fog is an abiding mystery of Russian space lore. He probably saved the crew's life by cleaning off the ventilator until choppers and frogmen fished them out in the morning. According to Russian space historian Geli Salahuddinov, Chernyavsky was fired for his unapproved initiative. Furious cosmonauts got him reinstated.

The Soyuz TM-26 crew that landed safely near here today is well versed in this history, and presumably is content with Kustanai's low-key hospitality, happy just to be back. In fact, the city fathers have turned out quite a crowd—replete with doe-eyed Kazakh maidens in native costume, sweetly bearing trays of bread and salt, traditional greeting gifts—by the time Mikhalishev comes whooshing up in his rescue helicopter a little after 2 p.m.

Anatoly Solovyev does his best to return the courtesy, staggering down the steps from the helicopter with a rescuer gripping each arm. He flops down on a bench, peering from a hooded

Oleg Fyodorov, the cosmonauts' physician, puts away Solovyev's spacesuit en route to Moscow (left). French space official Herve Stevenin is happy just to have his salamanders back safe and sound.


SOVFOTO/NOVOSTI

It isn't always an ordeal: The Soyuz TM-14 cosmonauts returned in 1992 to more hospitable weather and a more relaxed welcome.

sweatshirt with a look that seems a combination of extreme nausea and childlike wonder. But he gathers enough strength to lurch inside the airport, where Kustanai's mayor drapes a medal around his neck. Then the rescuers carry Solovyev out and everyone rushes for the Moscow-bound airplane. Anatoly Mikhalishev opens the window of his Mi-8 cockpit and looks on with a haggard grin.

The happiest man on the flight home is Nikolai Krayev, the strapping young blond rescuer who opened the hatch and pulled Tolya and Pasha to safety out on the raging steppe. Swigging vodka from a Coke bottle, he indulges in some well-deserved boasting. "These were extreme conditions," Krayev enthuses. "Write that down: e-x-t-r-e-m-e. Visibility was zero. That means nil."

The second happiest passenger is Herve Stevenin, who has not only his astronaut back but his salamanders too. Ecstatically, he lifts the reptiles to be photographed.

Leopold Eyharts, after three weeks in orbit, looks no worse than someone with a medium-intensity flu. The station proved a "very, very busy" place for the 40-year-old guest cosmonaut during his short tour on Mir. Week one involved "very intense adaptation" to weightlessness and the environment on board the station, he says. The rest of his stay was a blur of scientific work stretching from early morning until 10 or 11 at night.

I ask Vinogradov what he found most difficult about spending 200 days in space, and the 43-year-old first-time cosmonaut replies, "Lack of diversity in sources of information. All day long it's TsUP communications, and 99 percent of the information is professional. They sent us up newspapers once when the crew changed, but they were already a week and a half old."

During his half-year in orbit Vinogradov had time to mull over the emotional aspects of long-duration space travel. "You cannot battle with the cosmos. You can only get used to it," he reflects, then lapses into silence waiting for the next question.

Mir's designers know how to maintain the human body through extended exposure to microgravity. But Vinogradov suggests that there is no pat cure for the mental strain. "The most difficult situation occurs if you do not have understanding within the crew, when different people have different reactions to a situation," he notes enigmatically. He does not elaborate. Instead he calls to mind the gung-ho style of cosmonauts past, insisting that all he wants now is to prepare for the next mission. He does admit he might need a month to rest.

Vinogradov and Solovyev risked their lives to ensure that there would be more missions to Mir. Yet their efforts to patch the aging station may have been in vain. Russia's space leadership has ordered Mir moved into lower orbit, a first step toward junking it. Someday soon the heroics of Mikhalishev and Krayev will likely be consigned to history too. Seen through the cold eye of technological progress, the crash-landing Soyuz and the whirring Mi-8 are relics of the Soviet era, long past the prime of their lives.

Today, though, the tired cosmonauts can take satisfaction in a job well executed as they readjust to the sights and smells and gravitational tug of Earth. Not long after takeoff, a still wobbly Eyharts leaves his cabin to hit the bathroom, only lightly supported by the resident French physician. The small crowd goes wild.

COMMENTARY:

The 3-D Battlefield

It seems fitting that the last decade of the 20th century is also a decade of commemorations, recognitions, and celebrations: the 50th anniversary of the second world war, the 40th anniversary of Sputnik, the 50th anniversary of the formation of the United States Air Force, the 50th anniversary of supersonic flight, the 50th anniversary of the Berlin Airlift, and, sooner than might have been expected, the 10th anniversary of the end of the cold war.

Remember the end of the cold war? At the time, many pundits declared that it marked the beginning of a new millennium of peace, prosperity, and international cooperation. But less than a year later, 500,000 soldiers, sailors, and airmen in the Persian Gulf were preparing to go to war against Saddam Hussein. The years since Desert Storm haven't been any less daunting, with hostilities in Somalia, Bosnia, Rwanda, and the former Soviet republics, the expansion of the "Nuclear Club" to include India and Pakistan, and so on. The world is less stable, predictable, and harmonious than it was during the cold war, with a whole range of new conflicts, rivalries, and challenges.

This period of "new world disorder" has triggered tremendous interest among international security specialists, military strategists, and other experts in divining the nature of future warfare and of the United States' role in the world. Indeed, arguably the greatest national security challenge for the United States today is to develop an appropriate post-cold war grand strategy to confront the largely unpredictable world we are in. Regrettably, that has not yet happened. Instead, a Band-Aid approach to strategic thinking—scenario writing—has predominated.

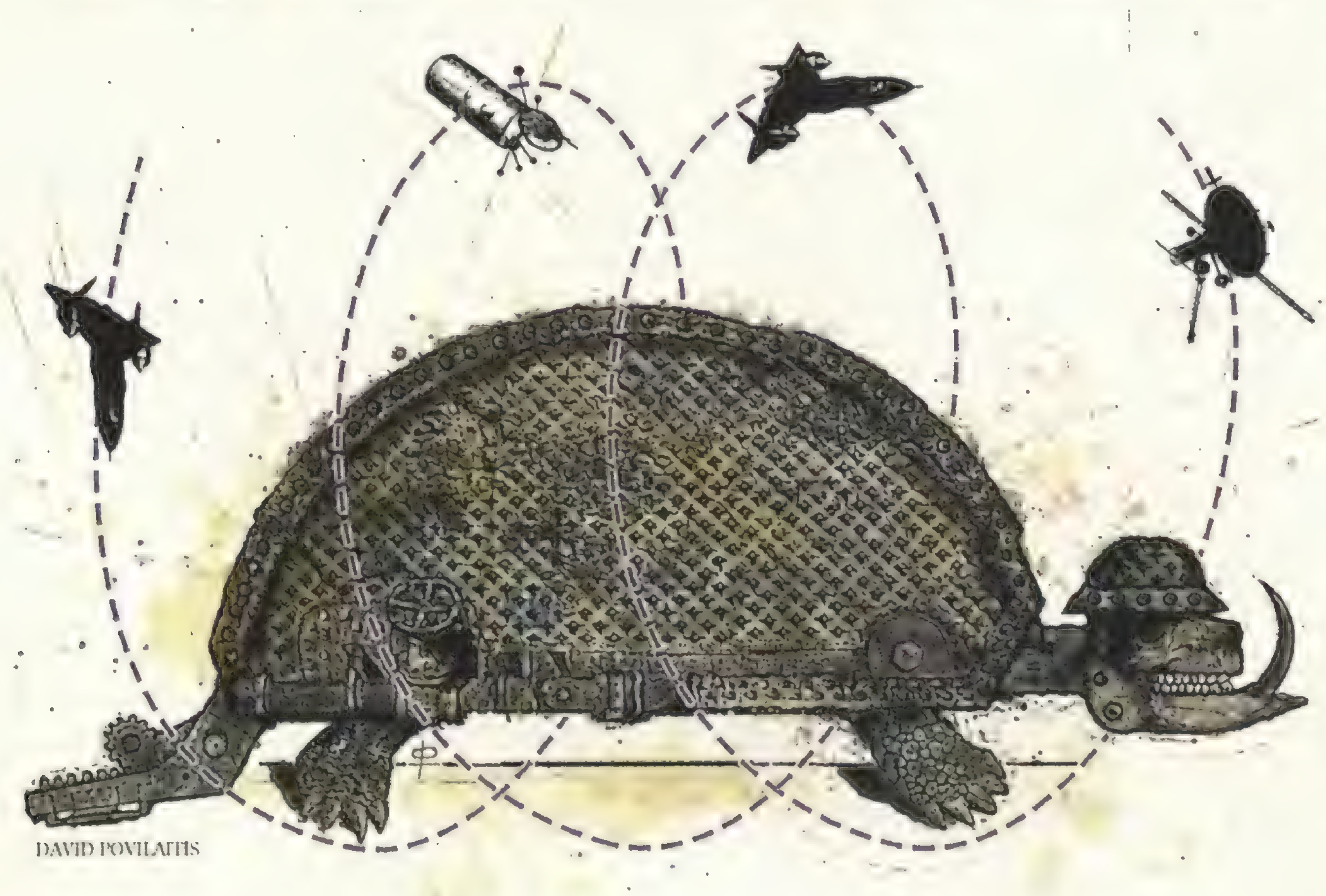
Two extreme scenarios mark the boundaries for most others. There's the scenario of widespread urban conflict that some see emerging from the callous shelling and sniping war in Sarajevo, the ethnic conflicts in Africa and elsewhere, and the rise of apocalyptic terrorist cults and criminal groups. In this scenario, future wars will be fought largely in the shadows, between urban security forces and mercenary, criminal, or terrorist opponents who exploit both the strengths and weaknesses of technology.

Then there's the scenario others forecast of manpower-intensive wars—a resurgent Iraq, for example—that require traditional large-scale maneuvering between standing infantry and mechanized vehicle forces positioning for battlefield advantage. In this view, the advances in technology, intelligence gathering, and communications made in the late 20th century will efficiently link traditional forces such as infantry, armor, and artillery, enabling them to fight more effectively.

There are, of course, no "one size fits all" wars. Imaginative as such military futurism may be, it is unlikely that these two scenarios are any more prescient or accurate than, say, the post-1945 forecasts that war would become unthinkable given the tremendous destructive capabilities of atomic weapons, or the more recent prophecies of the imminent demise of the fighter airplane and aerial dogfighting. Indeed, most military experts and analysts offer a broader assortment of scenarios ranging between these two extremes. But what is curious is the degree to which virtually all these studies are driven by the perception that what happens on the surface is necessarily more decisive than what happens above and below it.

At first look, such a bias might not seem unreasonable—until one considers the broader history of the 20th century. This is a century in which three-dimensionality—in the ability to fly above the surface and to maneuver beneath the sea—has increasingly ruled military affairs. This trend began as early as the first world war, matured in the second world war, and reached its fullest expression in both Operation Desert Storm and the 1995 NATO air campaign in Bosnia.

Even in wars where air power was less



DAVID POVILAITIS

Richard P. Hallion says it's time all U.S. military services—not just the Air Force—adopt aerospace power as their primary weapon.

successful (often due to technological insufficiency, bankrupt strategy, restrictive rules of engagement, or some combination of these), it had some surprising successes. Sea- and land-based air attacks in 1950 were decisive in halting the North Korean invasion of South Korea, and stemming the Chinese intervention that winter. In Vietnam, air attack repeatedly saved South Vietnamese hamlets from Viet Cong assault; in 1972, it shattered the North Vietnamese spring invasion and then, in December, sent North Vietnam back to the Paris peace talks and forced acceptance of a settlement (later thrown away by bad political judgment in the post-Watergate era). In other conflicts and contingencies—the Berlin Airlift, the Cuban Missile Crisis, the Arab-Israeli wars, and the Falklands War—fast-response, multi-service air power proved critical, even decisive.

Given this history, no one should be surprised by the conclusion of a recent study by the Center for Strategic and International Studies, a leading Washington think tank, in conjunction with the consulting firm VII Incorporated: "Air and space power can serve as the basis for creating a new approach to war...a new strategic paradigm.... The overall result would be a national military capability that is comprehensive in character, global in reach, swift in response, and highly effective in its actions."

Unfortunately, this viewpoint is strictly a minority opinion. Indeed, nearly a decade's worth of military studies and analysis by official bodies such as the Commission on Roles and Missions, the Deep Attack Weapons Mix Study, and the Quadrennial Defense Review, as well as the National Defense Panel, have been unable to define or promote any such unified multi-service vision. Rather, such efforts have bogged down in debates over roles and missions that echo the late 1940s: issues of command and control, traditional views of conflict and how it is pursued, fruitless debates (reminiscent of the angel-counting Scholasticism of the Middle Ages) over whether a revolution in military affairs has taken place and if so, what it is, and questions of budget priorities, size of forces, basing, and the like.

This is dangerous, for we need to rethink not so much the size of our forces as their composition. Put simply, the shift to the 3-D that occurred in warfare in this century is one that places far less emphasis on force-on-force surface encounters and far more on destroying enemy capabilities from above. It deemphasizes sequential seizing, holding, and ejecting and emphasizes simultaneous halting, controlling, and containing. With this comes the virtually implicit recognition of aerospace weaponry as the most effective means of confronting a potential foe across the span of conflict. This applies not just to air forces but to all services. It may be a missile-armed Army attack helicopter, an Air Force satellite system, a Navy carrier-based aircraft or cruise missile, an Army surface-to-air or surface-to-surface missile system, a Marine vertical-takeoff-and-landing aircraft or helicopter, a Coast Guard counter-drug maritime patrol airplane, or an Air Force long-range stealth airplane or cruise missile—but it is an aerospace weapon.

> We need to rethink not so much the size of our forces as their composition.

Though a reliance on surface-focused strategies and weapons continues to characterize most of Western military thinking, the message that aerospace power has radically transformed warfare has unfortunately not been lost on potential foes and international rivals. Since the Gulf War, there has been a sharp worldwide escalation in developing and procuring new aircraft and missiles and modifying older systems with new electronics and weapons to capitalize on the leverage aerospace weapons offer. As a result of weapons export and indigenous technical development, aerospace weaponry and capabilities are proliferating into crisis regions around the world. All this suggests that other nations, including some potential opponents, have learned far more from our recent experiences than we have, and thus could be better positioned to confront us in the future.

The history of weapons development through the centuries cautions us that at best the current U.S. superiority in aerospace warfare cannot continue without being taken to greater levels of effectiveness. But to do so will require changing our national strategy from its outdated, largely surface-centric mindset, a view that holds aerospace power as merely a supporting arm in warfare, to a multi-service aerospace-centric approach emphasizing the use of aerospace power as the primary means of confronting and challenging foes. Not using the full potential of aerospace technology will unnecessarily place far more of our soldiers, sailors, and air crew at risk—in effect, solving an adversary's problems, not our own.

The Air Force Historian, the author writes and lectures extensively on aerospace power issues. His most recent book is Air Power Confronts an Unstable World (Brassey's, 1997). This essay represents the views of the author and should not be considered an official position of the U. S. Air Force or the Department of Defense.

PHOTO ILLUSTRATION BY RANDY MAYS

COUNTERPUNCH

U.S. aircraft were easy marks for SAMs until the targets shot back. In the challenger's corner: the Wild Weasel.

by Robert A. Hanson

An F-100F, the two-seat version of the old frontline fighter, is leading a flight of four F-105D Thunderchiefs streaking behind a ridgeline into North Vietnam on December 22, 1965. The specially equipped F-100 is searching for surface-to-air missile (SAM) sites, to which it will lead the four F-105s. It had been only seven months since U.S. pilots had begun to fall to this dangerous weapon. As the hunters head into the SAM's lair, they aren't sure whether they will find it or it will find them.

In the back seat of the F-100, known, because of its unique mission and electronics, as a Wild Weasel, Captain Jack Donovan, an Electronics Warfare Officer (EWO), is intently focused on his instruments. In the front the pilot, Captain Allen Lamb, scans the terrain and keeps the flight low. The four F-105s have spread out behind Lamb and Donovan. As they pop above the ridge, Donovan gets a bearing on a tracking radar and yells a warning over the intercom.

The flight drops back down to hide below the protective masking of the ridge. When the aircraft come to the end of the ridgeline, they are suddenly over a flat valley. The flight turns left and starts to climb. Strong radar signals are displayed on Donovan's scope in the rear cockpit of the Weasel.

Lamb climbs higher, scanning frantically. There—in a small village to the left—a control van camouflaged to blend in with a surrounding village, and several white missiles. He pulls up sharply and rolls back down on them. He fires his two pods of rockets, but they hit short. Selecting guns, Lamb strafes the site with 20-mm cannon fire, explodes one of the long missiles, and pulls the sight up to the van. As he pulls up, the following Thuds roll in on their passes. The first SAM site in North Vietnam has been destroyed by a Wild Weasel-led attack.

The raid was a mere pinprick to North Vietnamese air defenses, but it represented the first use of specialized detection equipment cobbled together to detect the hard-to-find missile sites. The SAM wasn't a new weapon; it was first developed by the Germans during World War II, but not used in action. U.S. strategists had known about the Soviet-built SA-2 used in Vietnam since 1953. The missile was thought to have brought down Francis Gary Powers' U-2 spy-

Air Force Captains Al Lamb and Jack Donovan were the first to kill a surface-to-air (SAM) missile using special equipment to locate the radar source. By late 1965, star-shaped SAM sites were scattered across North Vietnam.

COURTESY AIR FORCE MAGAZINE ARCHIVES

plane in 1960, and one did destroy a U-2 flown by Rudolph Anderson two years later during the Cuban Missile Crisis. But the U.S. military did not begin to develop countermeasures until the missiles became a constant menace to U.S. aircraft conducting coordinated offensive strikes against North Vietnam.

SA-2 missiles were more than 30 feet long, carried more than 250 pounds of explosives, and could reach Mach 3.5 in pursuit of a target. Five months before Lamb and Donovan's mission, these weapons had drawn first blood: a flight of four F-4C Phantoms, climbing out from a strike north of Hanoi. One aircraft was destroyed and the remaining three sustained severe damage. In response, the Joint Chiefs of Staff directed a raid three days later against the suspected missile sites and supporting facilities, inside the once-restricted zone of Hanoi. The flight was mauled by anti-aircraft fire, and six aircraft were lost (see "Tullo and the Giant," June/July 1997).

Americans needed ideas, and the problem fell on Air Force Brigadier General K.C. Dempster, who began recruiting military and civilian technicians for a task force that met first on August 3, 1965. The urgency of the committee's task was brought home to them when a SAM claimed its first Navy victim—the pilot of a Douglas A-4 Skyhawk—shortly after the committee formed. Adding to the pressure, U.S. policy dictated that SAMs had to be faced after they were set up and operating. To the great frustration of U.S. air crews who watched the construction of SAM sites encircling Hanoi and North Vietnamese airfields, striking those missile sites, or even attacking cargo ships or trucks bearing the components, was not permitted.

PATCH COURTESY DAVID BROG

Dempster's committee recognized that the most obvious danger was posed by the SA-2s, but it was the invisible waves emanating from the radars (code-named Fan Song by NATO) guiding the missiles—and from Fire Can radars directing anti-aircraft artillery (AAA)—that represented the key problem to technicians devising effective countermeasures.

After first setting as a priority a reliable radar detection system, the team discovered that the technology already existed. Two radar homing and warning (RHAW) systems had been developed in response to an earlier Air Force requirement and were already in limited use in secret CIA air operations. Bendix had developed one system, and a small, relatively unknown company, Applied Technology, Inc., had produced a system packaged in five small gray boxes. The equipment, designed to help large aircraft avoid and jam radar, was called a Vector Sector, and it provided the basic electronics that could be used for offensive operations against SAM sites. Because the signals required to shield a large aircraft required so much power, the existing designs placed antennas strategically so that the jamming signals could be directed only where needed. "That [equipment] was in use at the time that all of the excitement began with the SAMs' arrival in North Vietnam," says Mel Klemmick, a former ATI field engineer. "There were certain people in the Air Force involved in those programs and they were aware of the capability, but no one could talk about the capability. We were the builders of both the jammers and direction-finding equipment, and we took a Vector Sector and repackaged it and gave it another number." But even before the equipment—which was designated the Vector IV system—had been designed, the elusive signals had to be analyzed and interpreted. "Unacknowledged, I think, is the work that went on in the

Even a fleet of fast aircraft like F-105s (opposite) were vulnerable to Soviet-built SA-2 missile sites (below). A single SAM launch could cause an entire formation to drop its weapons prematurely and take evasive action.

background to break the codes for the guidance signals," Klemmick says. "There was a lot of coordination between the intelligence community and companies involved—more than just ATI—coming up with a way to figure out what those original guidance schemes were."

The two-seat North American F-100F was selected to undertake the new mission. The F-100 (or "Hun," short for "hundred") was the Air Force's first supersonic fighter and was loosely derived from the legendary F-86 of Korean War fame, but by the time it was flown in Vietnam, it was being outpaced by newer and faster fighters. John Paup of North American Aviation was named program manager. Given the urgency of the situation, a meeting was quickly organized with ATI representatives in August 1965 to hammer out an agreement, and in an unorthodox manner that was to live on in Wild Weasel lore, the details were written on a chalkboard in a briefing room, signed by the authorized representatives, and photographed as the binding contract.

Under the cloak of a top-secret classification, an F-100F was rolled into a hangar at Long Beach, California, and placed in the care of North American's Kay Bullock, who had to find a place to stash the five boxes that made up ATI's system. Klemmick remembers Bullock's encyclopedic knowledge of the F-100 as vitally important, especially when first installing, and later repositioning, antennas after the Weasels had been deployed to Korat, Thailand. "He knew those airplanes so well that he'd take a big two-and-half-inch-diameter hole cutter, walk up to an airplane, and start drilling into the side of it," Klemmick says. "And the line chiefs are going, 'Oh my God...the fuel lines are in there.' 'No,' he'd say, 'I know exactly where I'm cutting.' And sure enough we'd shove an antenna there. No problem behind it."

The Vector IV system consisted of an array of small antennas mounted on the airplane to receive signals from every quarter. A panel of warning lights was mounted in the cockpit to indicate the type of signal being received: SAM, AAA, or conventional surveillance radar. A three-inch, television-like cathode ray tube was installed in each cockpit to provide a graphic indication of direction to the signal source. A WR-300 launch receiver, which was tuned to detect the burst of energy specific to a SAM launch, was connected to a bright red light in the cockpit, guaranteed to get the pilot's attention. Wild Weasel crews later referred to it as the "Oh shit" light.

The installation was crude and fast, and made use of commercial-grade wiring and other off-the-shelf components, but it enabled the first F-100F to be ready to fly in just 10 days. The system worked as advertised with only minor tweaks, and three more F-100Fs were rolled in for the same modifications. They were redesignated EF-100Fs for "electronic fighter," and flown to Eglin Air Force Base in Florida, where five volunteer crews selected to evaluate the system joined them on September 4, 1965.

Crew training was conducted at Eglin, which featured a full-scale Fan Song radar simulator being used to train B-52 Stratofortress and B-58 Hustler crews in electronic countermeasures techniques. The pilots and EWOs were encouraged to get to know each other and select their own partners, and there were adjustments to make all around—single-seat fighter pilots were not used to having another crewman on board, and most of the EWOs (soon to become

NASM

USAF VIA LARRY DAVIS

known as "bears") were completely new to fighter operations. Bears were experienced EWOs, drawn mostly from B-52s and EB-66 electronic warfare aircraft.

At Eglin, the new equipment installed in the F-100s was constantly modified and adjusted even as new systems, some of them to be fielded on future aircraft, were still under development. It was at Eglin that Bob Klimec, an Air Force pilot and electrical engineer, solved some of the basic problems associated with pinpointing SAM sites, and developed the basis of a defensive system that would eventually be installed on different aircraft types, including the F-111 "Aardvark," which was soon to make its debut in Vietnam.

Klimec set out to improve on the existing RHAW system, which only told you that a SAM was looking, or launching, and gave only a general bearing to the radar source. At this early stage in anti-radar development, before specially designed missiles that home in on radar signals were available, the target still had to be visually acquired and attacked with conventional weapons like rockets, guns, or bombs.

The Fan Song was one of the first electronic scanning radars—it directed its energy without having to move its antenna. "The way the Soviets built the Fan Song was to have [one] radar that tracks both the aircraft and the missile," Klimec says. "It would scan across 20 degrees and then go off the air, because you had to shut the radar down in order to preclude any kind of problems with the energy coming back inside and blowing out equipment—and then it would fly back, come back on again, and scan 20 degrees, and go off the air." The radar cycled several times per second and was directed so that a targeted aircraft was located at the center of the scan sector, which enabled the missile to be maneuvered freely inside, while the target was simultaneously tracked by the radar.

RICK LLINARES/CHECK SIX

Bookends: The two-seat F-100F (top) was the first Wild Weasel airframe, but it proved too slow and too old for the job. Today, with the addition of targeting pods, a wide variety of fighter aircraft can be SAM killers, including the F-16 Fighting Falcon (above).

"So it dawned on me that if we could detect when the radar came on, and we could determine when the aircraft was illuminated on the radar in the main beam, and we could detect when the radar shut down to fly back, we could calculate the position of the plane relative to the scan sector," Klimec says. It was known that the Fan Song took about 100 milliseconds to complete a scan, so if an aircraft was "painted" by the radar 50 milliseconds after the radar turned on, the aircraft was in the mid-point of the scan sector. "And the aircraft ordinarily did not get to the center of the sector unless somebody put him there—and since the tracking scan system could only track one aircraft to make an intercept on one aircraft, if you found yourself in the center of the scan sector and you

found you stayed there, then you knew somebody had selected you as a target," he says.

After design engineers devised equipment to verify Klimec's theory, he began monitoring the Eglin Fan Song simulator's emissions from the top of a hangar. "I talked on the phone to the radar site and got them to move it a little bit, and we verified that we could detect when the radar came on to start the scan, we could detect when it went off the air, and we could detect when

DAVID BROG

DAN PATTERSON

The F-105 was built for nuclear delivery, but its two-seat versions became the definitive Weasel platforms in Vietnam (above). In the rear cockpit (left), threatening radar signals appeared on the hooded screen in the center of the instrument panel.

we got the large spike of energy as the main beam came by," Klimec says. Klimec's innovation eventually allowed fighter crews to know whether or not they were targets and to take action only if they were.

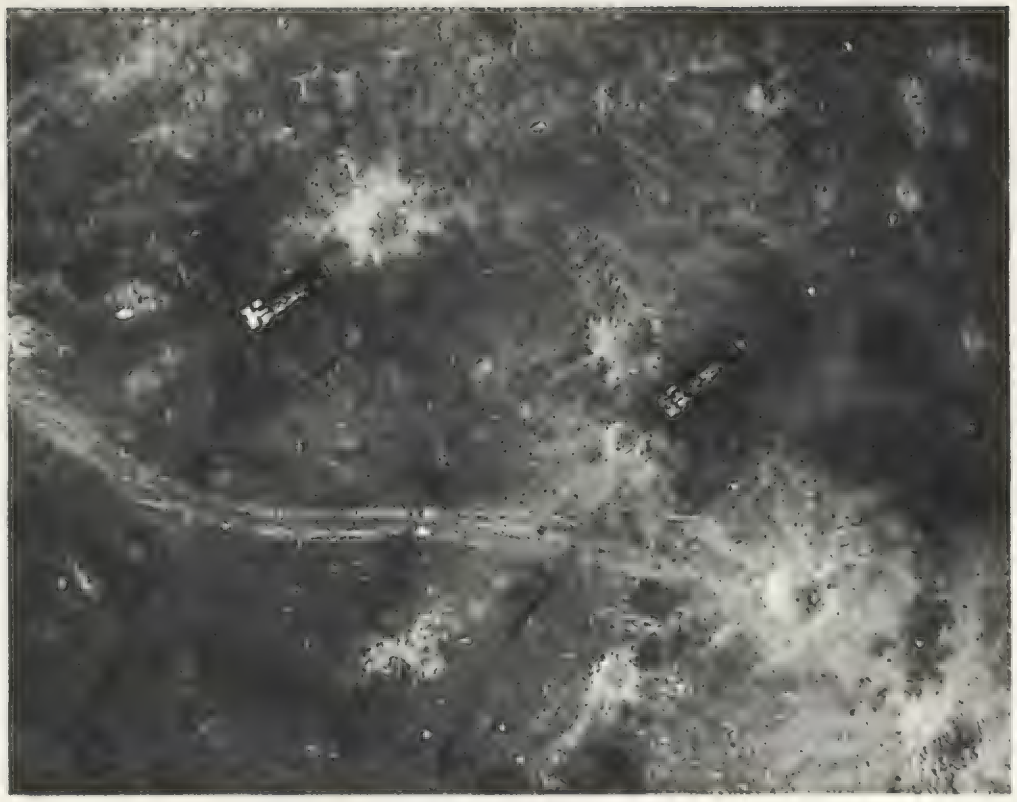
By the middle of November 1965, the Wild Weasels were committed to cutting their teeth in combat. Four EF-100Fs, led by Major Garry Willard, arrived at Korat Royal Thai Air Base on Thanksgiving day after a turbulent flight from Hawaii. Only 84 days had passed since the first F-100 had rolled into a hangar for transformation. But the equipment and tactics had yet to be proven. "Everything that went with the first contingent and with the first Weasels was all unqualified equipment," says Bill Hickey, a former ATI technician. "The need was so great we didn't have time to go through all the qualification testing and all that. And it worked, so who cared? But the biggest problem that anybody had was tactics, because nobody knew what the hell to do."

The North Vietnamese Army had not been idle while the Weasels were forming—U.S. air losses had been heavy. With the help of Russia and China, the NVA had developed a system of coordinated and layered air defenses that could be supplied and expanded at will, since President Lyndon Johnson had ordered that North Vietnamese harbors and rail links into China be off-limits to U.S. forces. NVA air defense depended on SAMs to dominate the medium to high altitudes, which caused the fighters, in their dive to elude missiles, to fly into a waiting hail of AAA, much of it radar-guided and accurate. The AAA became thicker the lower the altitude, and below 4,500 feet it became more lethal than the SAMs themselves. The plan was simple: Drive the attackers down into the lethal envelope, where they would be destroyed.

By December, the small cadre of Wild Weasel crews began checking out their equipment and devising tactics for their first missions. The crews flew orientation flights along the North Vietnamese border and became familiar with the various electronic signatures of NVA radar. When the Huns did head north, they accompanied strike packages to targets selected by the air staff. Intelligence about the location of SAMs wasn't always accurate, since the sites were mobile and could be broken down and moved in four to six hours. Wild Weasel missions were code-named Iron Hand.

As the Weasels flew, field engineers from ATI and North American were back on the ramp at Korat, working alongside Air Force crew chiefs and technicians under primitive conditions and dealing with constant changes to equipment and installation of subsystems. "We got into the field where they're changing engines out all the time and the wiring was deteriorating really badly," says ATI's Mel Klemmick, who was

sent to Thailand in 1965 for a tour that was to last 30 to 90 days but ended up stretching for two years. "Towards the end they were really falling apart. For example, you use commercial-grade coaxial cable for the rear antennas running right on the tops of those engines where the afterburners were. And particularly when they started flying the 100s out in front of the F-105s, those poor guys were in afterburner all the time."



COURTESY AIR FORCE MAGAZINE ARCHIVES

What every U.S. pilot loved to see: a bomb-cratered SAM site. Often a missile's launch plume made even a well-hidden site vulnerable to attack.

Because they often worked in concert with faster F-105s and F-4 Phantoms, even by the time the Weasels arrived in Thailand it was clear a more capable airframe was needed. Both the Thunderchief and the Phantom were logical choices, but the Phantom was a much more complicated machine: With twin engines, multi-role mission capability, and an extensive array of weapons to carry, it was much more densely packed with wiring, cables, and systems. Just finding space for the Weasel equipment was a challenge. Once the systems were installed, technicians discovered incompatibilities with the Phantom's existing electronics. Because of its difficult development and a string of intervening cease fires in Vietnam, the first F-4C Wild Weasels wouldn't reach Korat until 1972.

The conversion of the Thunderchief was much more successful and was to result in the most storied Wild Weasel airframe, and one that would fly the most missions in Vietnam. By January 1966, the first modified F-105F, with essentially the same equipment as the F-100F, made its first flight. The big Thunderchief had come out of the shop with its 20-mm Gatling gun still in the nose and the added ability to launch a new air-to-ground missile that fed on radar beams, the AGM-45 Shrike, a weapon that was partly based on the AIM-7 Sparrow air-to-air missile but had a Texas Instruments seeker head that locked on to ground-based radar sources. The Shrike was eventually carried by other U.S. Air Force aircraft, and was used by Navy radar suppression aircraft, including A-6 Intruders and A-4 Skyhawks; its appearance marked the beginning of more widespread SAM supression and offensive capability for a host of aircraft operating in Vietnam.

By May 1966, ten F-105Fs were on the ramp at Korat, bolstering the battered EF-100F contingent. The Thuds were flying sorties by early June, led

DAVID BROG

An impromptu flightline party marks the end of a tour for a Wild Weasel air crew. The missions were dangerous; such celebrations, rare.

by experienced crews in F-100Fs. When the Huns were withdrawn in July, they had proven the new system worked, pioneered a new mission, and destroyed nine SAM sites.

In mid July, the first Thud Weasels arrived at Takhli Air Base in Thailand. The air war was heating up at an incredible pace, and within six weeks, five Weasels had been lost and the sixth was too badly damaged to fly again. Operation over the north reached a long bloody plateau from late 1966 through early 1968. In 1967 alone, 26 Wild Weasel aircraft and 42 crew members—the equivalent of an entire squadron—were shot down. The losses prompted a reexamination of whether Weasel operations should be continued at all.

The surviving crews from the first deployment were sent to Nellis Air Force Base in Nevada to set up a Wild Weasel prep school that would provide new crews with instruction on the Vector IV equipment and 10 missions in the F-105F, some of them flown against dummy SAM radar sites. But for Wild Weasel crews, the best lessons were learned in combat. The training gave crewmen the basics of operating the equipment and included classwork on SAM radar and tactics, as well as simulated missions flown against the radar simulator. "We could learn how they operated, but actually seeing how they turn on, and seeing [a SAM] fire off and go by you [in combat] is another experience," says former F-105 backseater David Brog. "But [the school] prepared us and we were trained by guys who had been there already."

The crews experimented freely and developed their own tactics, even as their onboard equipment was continually modified. One of the more successful maneuvers against SAMs was developed by Takhli-based Weasels, who began forming teams made up of two pairs of aircraft: One tempted a SAM to fire, which revealed the site for the other pair to attack. This was a favorite trick of Leo Thorsness and his EWO Harold Johnson, a tactic they called "trolling." Thorsness also pioneered the lofted delivery—a sharp pull-up during launch of the Shrike that added as much as 20 miles to the nominal range of the missile. Thorsness and Johnson flew 92 Wild Weasel missions, one of which earned Thorsness the

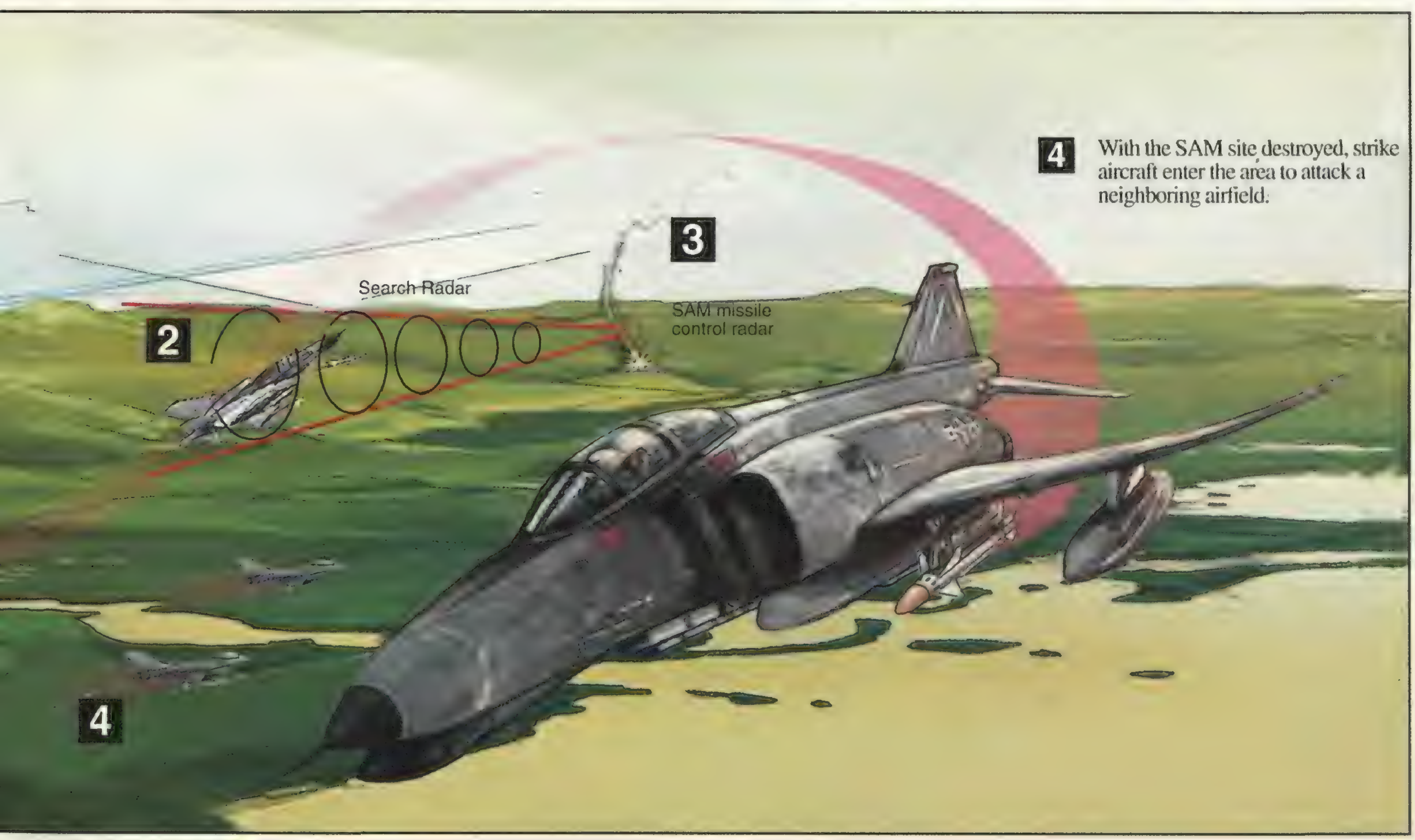


ILLUSTRATION BY WEB BRYANT

Medal of Honor and Johnson the Air Force Cross, but the two were shot down by a MiG in 1967 and spent the rest of the war as prisoners in Hanoi.

As tactics were developed in the air, field modifications to the Wild Weasel systems continued on the ground. A key weakness of the equipment was that if several SAM sites were displayed on the scope and the light that signaled a launch was illuminated, there was no way to know which site had fired and from which direction the SAM was coming. "I heard the crews complaining about that," says Weldon Bauman, who in 1967 was a junior enlisted technician at Takhli. "And I thought *Well, if I knew more about the signal, then maybe we could do something about it.*" Bauman became a Wild Weasel legend for devising a system similar to Bob Klemic's but that sidestepped cumbersome and lengthy procurement procedures and could be hot-wired into the aircraft in the field immediately. But to do it, he first needed access to sensitive data about the nature of SAM site radar emissions, and after convincing an EWO to escort him into the intelligence section, he got the information he needed. "I sat down and got the real-time data—the same day then was real time," Bauman says. "I found out what they were seeing and then went back and designed a circuit...and it worked." When activated, Bauman's modification cleared

JIM BENSON/CHECK SIX

In the Gulf War, the final Weasels, F-4Gs, carried AGM-88 HARM missiles and silenced Iraqi air defenses (above). In Vietnam, Shrike and Standard ARM missiles killed radars (below, top and bottom, respectively).

DAN PATTERSON

the scope of all information except for a blip that indicated the launching site. Tom Wilson, a former F-105 EWO, marveled at Bauman's ingenuity and his modesty. "This kid had two stripes, and he was so damn smart it was unreal," Wilson says. "When I asked him how he came up with the mod, he said, 'It was real easy. Just three little parts wired into the line for the scope, and a switch, and it was done.' "

However, such advantages were sometimes short-lived. "I've been asked to describe electronic warfare to new guys coming on board in the industry, and I tell them that you've got to look at it as a giant circle," former ATI technician Bill Hickey says. "You make changes because you want to improve your equipment. Well, the instant you do that, and the guy on the ground finds out, he's going to make a change."

Often it didn't matter if the air crews knew where the SAMs were coming from—there were too many to effectively track. "Somewhere along the way, someone convinced the NVA to fire the SAMs in threes, and that is what they would do," Wilson says. "So, here comes three from one side, three from another, three from behind, and they are all pointed at you. It made for tough decisions."

Some air crews witnessed a further step taken in the electronic gamesmanship: simulated SAM launches. "We used to joke about the Russian technician teaching the NVA and saying, 'See that big formation right there on the scope? Well, watch this,' " says Bill Sparks, a former F-105 pilot. "He would hit the button, and the formation would look like the world's biggest bomb burst as everyone jettisoned their loads and went crazy looking for a launch. Kinda funny, really."

As the air crews gained experience monitoring the signals coming from Fan Song radars, the abilities, tendencies, and personalities of certain ground operators began to emerge, sometimes evoking grudging admiration from pilots and EWOs. One such site was located at Vinh, North Vietnam. "In my day, that guy was famous," says former F-105 Weasel pilot Jerry Hoblit. "He was isolated from everybody else. He was the cagiest guy in the world. You talk to anybody who flew when I was there and they say, 'I want to meet the guy that ran that [site] and buy him a drink.' "

Hoblit vividly remembers being trumped by the Vinh operator during

a night mission. "I had a preplanned strike launch all figured out coming off the water, where I used the radar and got a good range on him," Hoblit says. "So I was doing this trick and it was a pretty high angle. I think I was launching [a lofted delivery of the missile] around 30 degrees. And right...after I launched that Shrike, I'm still kind of floating and up comes the Fan Song [transmitting a launch signal].... I'm all out of airspeed and about everything and it's night, and I'm over an undercast...everything went from good to bad in an instant. And Tom [Wilson, Hoblit's EWO] is yelling at me, calling me a very bad name." Hoblit doesn't think the operator actually fired a missile at him, but knows his own attack against the Vinh operator failed miserably. "That was typical. I wasn't so dumb. He was just smart," Hoblit says.

Despite the heavy toll on Wild Weasel crews in Vietnam, losses of all types of aircraft to SAMs began to decrease in 1967. In addition, by late 1966 components from the original Wild Weasel equipment were being installed in many aircraft types, which provided the pilots of non-Weasel aircraft some measure of radar detection and enhanced their existing ECM equipment. The F-105 and the technology developed for its use had finally begun to pay off and turn the tables somewhat against the dreaded Fan Song and SAM.

Missile technology improved also. In 1968 the USAF introduced the 15-foot-long AGM-78 Standard ARM, which was designed around a Navy shipboard surface-to-air missile. Later improvements to the missile enabled it to lock on to a radar signal up to 60 miles from the source. The Standard ARM was used in combat most extensively by the F-105G, which came with better electronics and built-in ECM equipment that eliminated the need for external jammer pods.

Under development in the closing stages of the Vietnam War, the ultimate Weasel, the F-4G, would offer an all-new McDonnell-designed system built around a Texas Instruments computer board. Target and threat information was projected on a head-up display on the pilot's gunsight. The F-4G could carry both Sparrow and Sidewinder air-to-air missiles, plus all air-to-ground missiles, including the new High Speed Anti-Radiation Missile, or HARM.

The F-4G, a product of lessons learned during Vietnam, operated in the Gulf War and served until 1996. The overwhelming success of allied air operations provided a fitting end to the Wild Weasel—Desert Storm represented everything that Vietnam, with its mix of politics and warfare, wasn't. No Wild Weasel aircraft were lost, and today F-16s have assumed the Air Force's radar supression role—they use bolted-on targeting pods housing radar acquisition equipment in a compact package that works in concert with the AGM-88 HARM. A variety of Navy and Marine Corps aircraft also carry the HARM. The F-16 will be followed by the Air Force's newest fighter, the F-22 Raptor, which will likely have an integrated anti-radar capability. It may take another war, one more like Vietnam than Desert Storm, to prove whether a targeting pod slung under a wing can match a dedicated Wild Weasel air crew. When tomorrow's pilots test the wisdom of the decision, they'll carry with them the heritage of a courageously executed mission, equal parts planning and improvisation.

HARM-carrying fighters, including Navy and Marine F/A-18s, take advantage of the missile's fire-and-forget programmed guidance.

RANDY JOLLY

"Live, From the Chopper..."

In New York City, TV news crews compete for both stories and airspace.

Not long ago in New York City, Channel 4, the NBC TV affiliate, began promoting its news shows with enigmatic commercials that alluded to a "new Chopper 4." You saw a backlit windscreen and tail rotor, and the voiceover mysteriously intoned: "There's nothing else like it."

Meanwhile, Channel 2, the CBS affiliate, tried to grab some attention for its existing Chopper 2 by bragging about its recently acquired $200,000 infrared camera. And Channel 7—ABC—ran spots boasting it had two NewsCopter 7s. Even the popular Spanish-language Channel 47, Telemundo, got into the act, advertising its chopper (which curiously looked like the second NewsCopter 7), as did Fox affiliate Channel 5, with—what else?—Chopper 5.

TV news helicopters have become as much a part of life in New York City as games of three-card monte. Today, of the six English-language TV news divisions that operate in the New York City area, four have choppers. The other two broadcast only evening news and so have no need for workday traffic reporting—but both say they're open to the possibility of getting choppers. For now, they, plus several radio stations, share coverage from a pool chopper (that second NewsCopter 7).

And it's not enough anymore just to have a chopper. Each station wants to be known for having the best—the fastest, the nimblest, the most vigilant. Channel 4's PR person wouldn't even talk about the old Chopper 4, or let me talk to anyone there about it. If I wanted to write about 4's air coverage, I'd have to wait until the new, improved, nothing-else-like-it Chopper 4 was ready.

The news choppers flying today are actually a second generation. The first appeared in Los Angeles back in the 1970s, according to Dave Vanderslice, vice president of aviation and facilities for Metro Networks, which equips, maintains, and crews news choppers in 17 television markets across the United States. (All stations use outside companies to maintain and operate their choppers.) L.A. was a natural, Vanderslice says: Its overcrowded highways kept viewers hungry for up-to-the-second traffic reporting. Then too, traffic can move so slowly that a news van dispatched to cover a house fire would reach the scene around the time a bull-

by Phil Scott

Illustrations by David Peters

dozer was shoveling away the debris. The news-by-air concept spread to New York's news stations, but the setup was expensive and the picture quality mediocre, so eventually the practice faded away.

Two developments brought *Helicopterus newsgatherus* back from extinction. In the early news choppers, the cameraman had to perch with his feet on a skid while holding a camera on his shoulder. The new generation of cameras are mounted on the airframe and stabilized with gyroscopes, so the cameraman or reporter can shoot from inside the cabin. The second development occurred in June 1994, and introduced the term "low-speed chase." "The whole craze can be attributed to the O.J. chase," says Vanderslice. "If you didn't have a helicopter in that market you were out of the story."

If that didn't put fear into the hearts of New York's media warriors, two local events would: The following summer, a runaway brush fire threatened to torch Long Island's pine barrens, a favorite getaway spot for Manhattanites. Then, in 1996, TWA Flight 800 went down off of Long Island.

"Certainly a lot of television stations found that 60 miles off the coast, the only way to get any coverage was from the air or a boat, and you can't see much from a boat," says Danny Toy, director of New York City's Metro Traffic Control, the local divison of Metro Networks. TV stations scrambled to hire helicopter operators. Then the rescuers slapped a no-fly zone around the area, and the helicopters had to operate outside the debris region. If you didn't have a gyro-stabilized camera with a telephoto lens, your footage would look like it had been shot from a vibrating motel bed.

Today, with multiple helicopters often converging on a scene, flying over Manhattan can be a tense business. "All the choppers have at least two radios, one to talk to air traffic control and another to talk between us," says Oyvind Vataker, who flies a Eurocopter A-Star AS350BA for Channel 5. "You come up and find the spot and you tell the other guys when you're gonna move. If it's a big story and the spot is tight, there can be a little bit of a fight to get the good shot. But pretty much everybody is pretty good and we work it out. One gets in and goes live, then he gives the spot away."

"The first on the scene has priority, and that cranks up the pressure a notch," says Ray McCort, who has flown for Channel 7, the tabloid TV show "Hard Copy," and feature films. "Working for the station you have that certain stress that you need to be number one on the spot. Without that you can't justify the helicopter."

Besides aggressive flying, stations compete with technology. One much-touted example: Chopper 2's infrared camera. "It's bringing back unprecedented pictures that allow you to see things we wouldn't be able to see without it," WCBS spokesperson Adrienne Schwartz assured me.

Competing stations say they aren't convinced. "For the most part it turns color pictures into black-and-white," says Bart Feder, news director of Channel 7. What really makes great aerial footage, he adds, is the quality of the lens and its multiplication factor—how crisply it can zoom in on something from a distance.

"Trust me, we have found it well worth the investment," responds Schwartz. She explains some of the benefits: Viewers can see the hot spots in a fire, images in a low-light or no-light situation, or even someone wandering in a forest, presumably lost or evading authorities. When asked for examples of actual scoops that the camera has brought in for the station, Schwartz can't recall

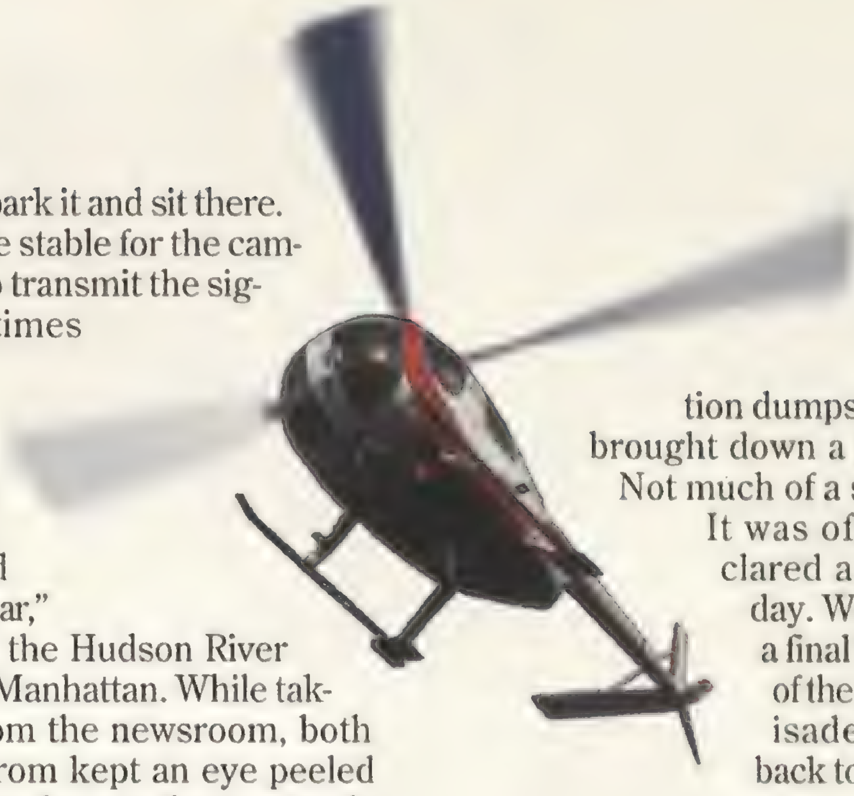
any. "But we're able to see things that other cameras would not be able to," she says. "Interestingly enough, we've helped fire fighters fight fires. Once the firemen wanted to go up and see the vulnerable parts of the fire. They didn't do it, but they expressed the desire to."

After listening to her testimonials, I eagerly tuned into Channel 2 hoping to see some infrared camerawork. I got lucky: Later that day Chopper 2 was covering a Brooklyn apartment fire, with lots of flames and firemen on ladders and emergency vehicles flashing lights. To illuminate the fire, the chopper's cameraman switched briefly to infrared. The footage looked like a low-budget sci-fi movie shown on a black-and-white set. Maybe I'll have to wait until a forest grows in the city so someone can get lost in it.

One morning I went along for a flight with the crew of Chopper 5. The first thing I noticed about the A-Star was its paint job: sky blue on the left, gloss black on the right. A station publicist had explained that when the craft appears on the local Fox morning show, "Good Day New York," it's called High 5, and when it shows up on the afternoon and evening news telecasts, it's plain old Chopper 5. Miniature cameras are positioned on both sides of the tail's stabilizer to send shots of the appropriate side.

With Oyvind Vataker, who goes by O.V., at the controls and Ken Ostrom on the camera console—both cracking wise about a Norwegian ship that had run into a bridge the night before—we set off at 6 a.m. on our first sortie: to hover above and shoot a wreck of a tractor trailer that had been cleared from the New Jersey side of the George Washington Bridge. There were several high-rise apartment buildings nearby, and the crew was conscientious about staying as far from them as possible for as long as possible, but when we did move in, we hovered long and low enough to wake the residents. Ostrom slowly zoomed in on the mangled vehicle while on air the anchor chattered on about the backup.

"The most unique thing you do in ENG [electronic news gathering] is you do a lot of high-altitude hovering," O.V. said later. "You come up on a scene, you basically park it and sit there. You need to be stable for the camera and also to transmit the signal. A lot of times when you move, the signal will break up."



When the newsroom told us we were "clear," we flew down the Hudson River toward lower Manhattan. While taking orders from the newsroom, both O.V. and Ostrom kept an eye peeled for seconds-long beauty shots—people jogging, ducks flapping—to "bump" in and out of commercials and to use during the weather briefs.

As we cruised down the East River, I noticed another helicopter pacing us about a mile away. "Who's that?" I asked, really more to alert the crew to the threat of collision. "That's *Chopper 2*," O.V. sang out, echoing a well-known commercial, and then he and Ostrom chorused "*with infrared camera!*"

Over lower Manhattan we hovered for a beauty shot of the sun rising between the World Trade Center's twin towers. Then the station radioed us that one of its news vans had gotten caught in traffic and asked us to locate a reporter on a street corner a thousand feet below, bear in on him with the camera, and relay his live feed to the station. Our navigation method was disarmingly low-tech: The reporter gave us his street address and Ostrom found it on a street map.

Hovering just feet above and away from some of the tallest, most densely packed buildings in the Western Hemisphere, I tried to distract myself by watching the broadcast on a monitor in the left seat. O.V. is a good pilot, but I was still relieved when the program director told us to head into New Jersey to cover another traffic jam.

Less than 10 minutes later we were on the scene. A disabled vehicle was causing rubberneckers to plug the highway. I looked over and noticed that one of the NewsCopter 7s had taken up position a few hundred feet away from us.

Suddenly, off to our left, both Ken and I saw a flash and a puff of smoke. With the station's permission we flew over to investigate. It turned out a truck driver had been unloading a huge construction dumpster and had brought down a power line. Not much of a story there. It was officially declared a slow news day. We broadcast a final beauty shot of the Hudson Palisades and flew back to the airport.

Not long after my flight, Channel 4 finally broke its silence about the New Chopper 4. Actually, the station held a press conference unveiling the machine, and I was shocked that none of the other stations assigned reporters and cameramen to cover the news. The New Chopper 4 turns out to be a Eurocopter EC 135, capable of a blistering 172 mph, nearly 20 mph faster than the old Chopper 4—which, they would now finally tell me, was a single-engine Eurocopter A-Star 350. The new machine had seven onboard cameras—versus five on Old 4—including a night-vision camera that turns New York City a dim green. There are two engines, which makes it safer should one stop working in flight; an enclosed tail rotor, to make it quieter and also safer in case someone decides to try walking into it; and a big Channel 4 logo on the bottom, so if you're awakened at six in the morning thinking you're in the middle of a scene from *Apocalypse Now*, you'll know who's responsible. The price tag: $4 million.

News choppers are now turning up in some unlikely places. A friend tells me that even in Portland, Oregon, one TV station now flies not one but two choppers. At first he marveled at the new perspectives on his town. "But *two* helicopters?" he says. "It's Portland, for God's sake."

Maybe we're reaching critical mass, and the next development in the Chopper Wars will be disengagement. Channel 5, which initially ran commercials touting its chopper as "New York's air superiority," recently began running one with a different catchphrase: "Fox 5: More news, less chopper."

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GEMINI
AGENA

Flying the Gusmobile

Gus Grissom made sure the Gemini spacecraft had one requirement its predecessor didn't: pilots at the controls.

by D.C. Agle

Illustrations by Web Bryant

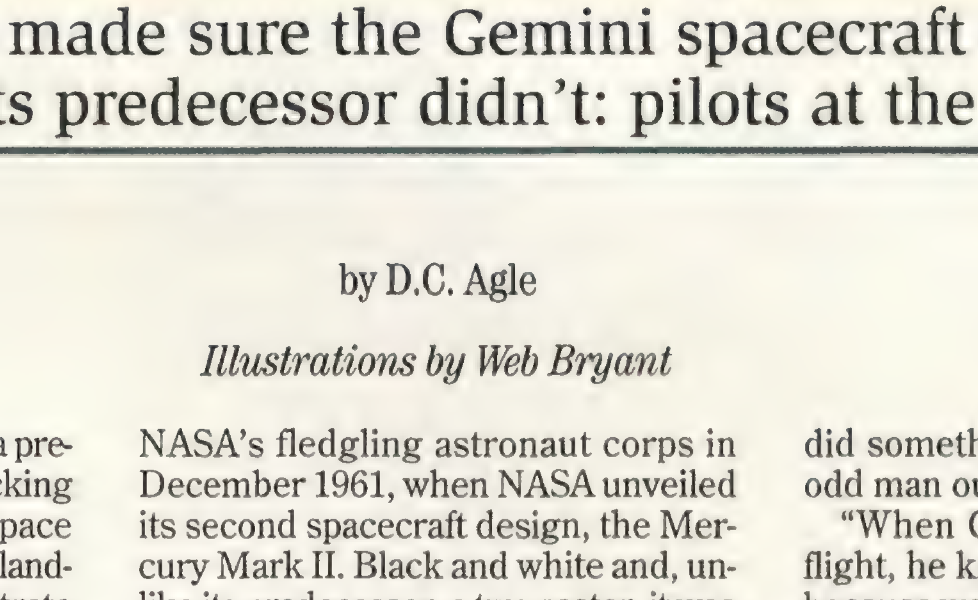
Whether they are executing a precision rendezvous and docking maneuver with the Mir space station or greasing another shuttle landing, astronauts routinely demonstrate that they are among the best pilots on the planet. But back at the beginning of America's space program, it looked like just about anybody could have done the job—and the overqualified men tasked to fly Project Mercury knew it.

"I initially said they should take one of those circus performers they'd shoot out of a cannon because Mercury wasn't a 'pilot in space,' it was a 'human in space,' " says Wally Schirra, a member of NASA's first astronaut class. "We didn't really contribute very much to the flight of the vehicle. We were lab specimens."

On Mercury, the astronaut was along for the ride. A booster would launch him and retrorockets would bring him back down. In between, nothing on the Mercury capsule would allow him to perform the simplest of pilot acts: alter his flight path. Sure, he could turn, pitch, and roll this way and that. He could see where he came from and where he was going. But for the Mercury astronaut, where he was going was a done deal only minutes into the mission. The very instant the booster's engines shut down, the capsule's trajectory was set.

But things began looking up for NASA's fledgling astronaut corps in December 1961, when NASA unveiled its second spacecraft design, the Mercury Mark II. Black and white and, unlike its predecessor, a two-seater, it was soon renamed Gemini, after the zodiac sign for twins. But many of the pilots who would ride the enlarged Mercury-type capsule into orbit gave the spacecraft another handle. They called it the Gusmobile.

That's "Gus" as in Virgil I. "Gus" Grissom.



"Gus really had a big hand in everything, from the way the cockpit was laid out to what instruments went where," says John Young, Grissom's partner on the first manned Gemini flight, Gemini 3. "It was his baby."

Grissom, like Schirra, was a member of NASA's "Original Seven" Mercury astronauts and on July 21, 1961, became America's second man in space. But the same suborbital Mercury flight that put Grissom in the history books did something else. It made him the odd man out.

"When Gus finished his Mercury flight, he knew he was out of the loop because we had to go through the seven…," Schirra says. "And he looked at it and said, 'My God, we are not going to have that many flights! I'm going to go up to St. Louis and play with Gemini.' So it was essentially his spacecraft. He practically had it to himself."

NASA had been wrestling with the idea of a Mercury followup since 1959. Its goals evolved into something more lofty and much more complex than just putting two men inside a somewhat larger Mercury capsule and hurling them into the unknown. It became a testbed in which to prove all the major concepts needed for a manned mission to the moon. Could man survive in zero-gravity long enough to travel from Earth to the moon and return? Could astronauts manipulate their trajectory with enough precision to rendezvous and dock with another spacecraft? Could an astronaut leave the relative safety of the spacecraft's cabin and "walk" in space? And finally, could an astronaut control his spacecraft's reentry into Earth's atmosphere?

Gemini would tell them.

What Grissom would tell the engineers at McDonnell's St. Louis plant, where the Gemini was being built, was

NASA

Astronaut Gus Grissom—here climbing into a Gemini spacecraft for a February 1965 communications test—advised McDonnell engineers on how to make the craft a pilot's vehicle.

how to make it a pilot's spacecraft. "Since we had to fly the beast, we want one that will do the best possible job," he wrote in *Signal* magazine before his Gemini flight. Grissom, who died with astronauts Edward White and Roger Chaffee in the January 27, 1967 Apollo 1 fire at Florida's Cape Kennedy, became a spokesman for the astronauts during the design of the vehicle. And he was determined to see that the limitations of Mercury were not repeated. In a Gusmobile, the astronaut was going to be an integral part of the system rather than a backup.

The McDonnell engineers took such preaching from a "flown astronaut" as gospel. "I would sit in the mockup for hours," Grissom wrote in *Life* magazine. "All I had to do was say 'No, I don't like it' or 'Yeah, it's okay.'... When the other [astronauts] started looking at the Gemini mock-up it was pretty clear it was designed around me." Indeed, the spacecraft designers had tailored Gemini's cockpit so closely around the five-foot, six-inch Grissom that Gemini became a tight squeeze for everyone else. By July 1963 NASA had discovered that 14 of its 16 astronauts could not fit into the original Gusmobile design. Since the external dimensions and seat configurations were fixed, designers were forced to eke out a little more room by reducing the size of a safety kit and reshaping the inside surface of the hatch by the astronauts' heads.

But there were other reasons for the Gusmobile's confining dimensions. The Gemini design had to pack two astronauts, one heatshield, 1,000 pounds of fuel, five parachutes, and a whole bunch of oxygen, rocket motors, a life support system, a computer, guidance and control devices, and other equipment into a tight yet tidy 8,000-pound package—a requirement made necessary by the maximum payload weight of the booster that launched the Gusmobile and its occupants into space (see "Riding the Titan II," p. 54).

The real test of the Gusmobile came once the spacecraft reached the high ground of space, where the crew's usual first order of business was proving that Project Apollo's plan for lunar orbital rendezvous was sound. The astronauts knew if they could not pull off a rendezvous and docking with another spacecraft in Earth orbit, they didn't have a prayer of accomplishing the feat 250,000 miles from home. For these first rendezvous, the Gemini crews would have to navigate and change altitudes, speeds, and headings. Essentially, for the very first time, astronauts had to act like pilots.

"Gemini was like flying a high-performance fighter," says former Navy test pilot Pete Conrad, who was the pilot on Gemini 5, command-pilot on Gemini 11, and, later, commander of Apollo 12. "You did everything manually. You flew it. Apollo was all about your computer. You get 30 seconds or a minute on the stick landing on the moon and everything else was done through the computer. I don't know how much stick time I had on Apollo 12 but it was very little. But on Gemini everything was stick and that included all the burns for the rendezvous."

Logging some stick time on Gemini actually meant using two sticks, or "hand controllers." The attitude hand controller was in the center of the spacecraft, between the command-pilot on the left and the pilot on the right. (For the group of pilots flying the first piloted spacecraft, "co-" was not an option.) Within easy reach of both, the attitude hand controller did just that—control the spacecraft's attitude, or the direction in which it was pointing. By moving the controller backward or forward, left or right, or by twisting it, an astronaut fired any of eight 25-pound thrusters

NASA

Looking more like a sculpture than a spacecraft in protective wrapping, the Gemini 6 vehicle was hoisted up a gantry at Florida's Cape Kennedy for pairing with a Titan II booster.


NATIONAL ARCHIVES

located in the bottom of Gemini's white adapter section, yawing, pitching, and rolling the Gusmobile.

The attitude hand controller was old news, however; it had been used in Mercury as well as on some Soviet space missions. The significant innovation on Gemini came with the insignificant-looking T-handle controllers, one to the commander's left, another to the pilot's right. These were translational hand controllers. Pushing one forward out of the neutral position in the center would fire two 100-pound thrusters at the rear of the adapter section. Pulling it back, up, or down would fire other thrusters in the center of the adapter, moving the entire spacecraft backward, up, or down from the pilots' reference point (see "In the Cockpit," next page).

"The procedure is simple," Grissom said at a March 1965 press conference, shortly after putting the spacecraft through its paces for the first time during Gemini 3. "All we do is turn on the OAMS—the Orbital Attitude and Maneuvering System—and pull out the throttle I have on my left side, put the nose on the horizon, and start thrusting."

In doing so, Grissom flew history's first orbit changes; another important first came later that year during the flight of Gemini 6, when command-pilot Wally Schirra brought his spacecraft within inches of Frank Borman's Gemini 7. The maneuver required more than 35,000 individual thruster firings. "It was like the Blue Angels at 18,000 miles per hour," Schirra says, "only it was easier. There is no turbulence in space so there were no bumps in the road. Also, the Gemini was magnificent to fly! I was amazed at my ability to maneuver. I did a fly-around inspection of Gemini 7, literally flying rings around it, and I could move to within inches of it in perfect confidence."

The Gemini astronauts had achieved history's first rendezvous in space—although their competition saw things differently. "Around that time," Schirra explains, "the Russians flew two spacecraft within three miles of each other and said they performed the world's first rendezvous. No way was that rendezvous! It was a passing glance—the equivalent of a male walking down a busy main street with plenty of traffic whizzing by and he spots a cute girl walking on the other side. He's going 'Hey wait' but she's gone. That's a passing glance, not a rendezvous." He adds: "Now if that same male can cut across all that traffic and nibble on that girl's ear, now that's a rendezvous!"

Gemini's usual target was an unmanned Agena-D. Launched by its own Atlas rocket 100 minutes prior to the crew's launch via Titan, the Agena was a combination docking target and booster rocket. At one end it had a gimbal-mounted, turbopump-fed 16,000-pound-thrust rocket engine and plenty of fuel. At the other was a Gemini-compatible docking target replete with radar transponder, flashing xenon lights, shock absorbers, and mooring latches. For the

Five months before their Gemini 4 flight, James McDivitt (opposite, left) and Edward White watched the January 1965 launch of Gemini 2, an unmanned suborbital flight. Between March 1965 and November 1966, the Gemini program pulled off an impressive 10 manned missions.

world's most proficient test pilots, the Agena was a piece of cake.

"Docking in space is cool," says Dick Gordon, who was a Navy test pilot before he flew Gemini and Apollo missions. "As a young aviator I'd done my fair share of air-to-air refueling and that was what docking with the Agena was like. You get yourself lined up, maybe five to ten feet out. And if everything looks all right and you look lined up with the docking cone, all you do is add a little thrust with the translational controller. And if it looks like you're going too fast you take a little off with the translational controller. And just like flying an aerial refueling, you did all this with just the old Mark-VIII eyeball. There was no optical sight on board like I had for docking the [Apollo] command module with the lunar module. It was all feel."

The actual encounter occurred at a walking pace: half a foot per second. Gordon calls it "little more than a bump in the road and hardly felt." The Gemini's index bar—a vertical bar on the end of Gemini's nose—slid into a V-shaped notch at the top of the Agena's docking cone. At the point of contact three clamps inside the Agena grabbed hold and pulled the spacecraft closer, and electrical cables connected, enabling the astronauts to control the Agena-Gemini stack.

"I had the ability to maneuver the Agena from the right side of the Gemini's cockpit," Gordon says. "There was this little coder—the 'Orphan Annie coder,' as I called it, because it looked like one of those little ring decoders kids used to get. By working the coder's rings and hitting 'send' by moving a lever to either '0' or '1,' you could transmit signals to the Agena. You could do everything from tell the Agena what direction it should point, to fire its big engine."

During the Gemini 10 and 11 missions they did just that. The right-seaters on those missions (Michael Collins on Gemini 10 and Dick Gordon on Gemini 11) ended one of their long digital conversations with the Agena by sending the sequence 041-571-450-521-501, the command to fire the engine. After an 84-second pre-fire routine, John Young and Collins on Gemini 10 and, later, Pete Conrad and Gordon on Gemini 11 became spectators at an out-of-this-world fireworks display.

"At first, the sensation I got was that there was a pop, then there was a big explosion and a clang," John Young said at a mission debriefing following Gemini 10. "We were thrown forward in the seats.... Fire and sparks started coming out of the back end of that rascal.... The light was something fierce and the acceleration was pretty good.... The shutdown on the PPS [Primary Propulsion System] was just as unbelievable. It was a quick jolt...and the tailoff...I never saw anything like that before, sparks and fire and smoke and lights."

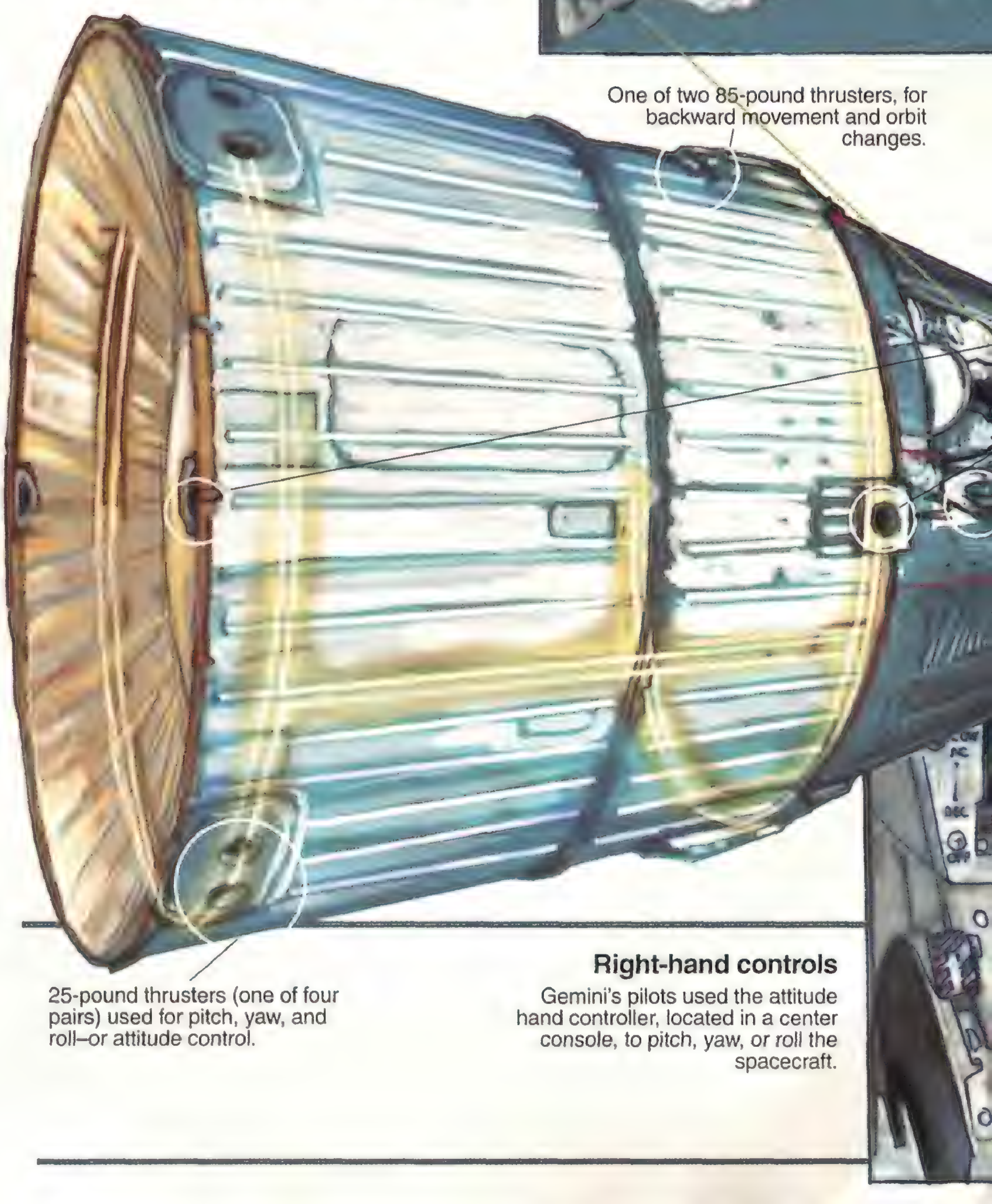
On September 14, 1965, 25 seconds' worth of sparks, fire, smoke, and lights lofted Gemini 11 to a new Earth orbit and an altitude record of 853 miles. Conrad and Gordon became the first humans to witness the planet in true spherical splendor.

"We went over the top and I said,

In the Cockpit

Left-hand controls

The command-pilot pulled back the translational hand controller to move the spacecraft backward, pulled it to either side to move the spacecraft laterally, and so on.



One of two 85-pound thrusters, for backward movement and orbit changes.

25-pound thrusters (one of four pairs) used for pitch, yaw, and roll–or attitude control.

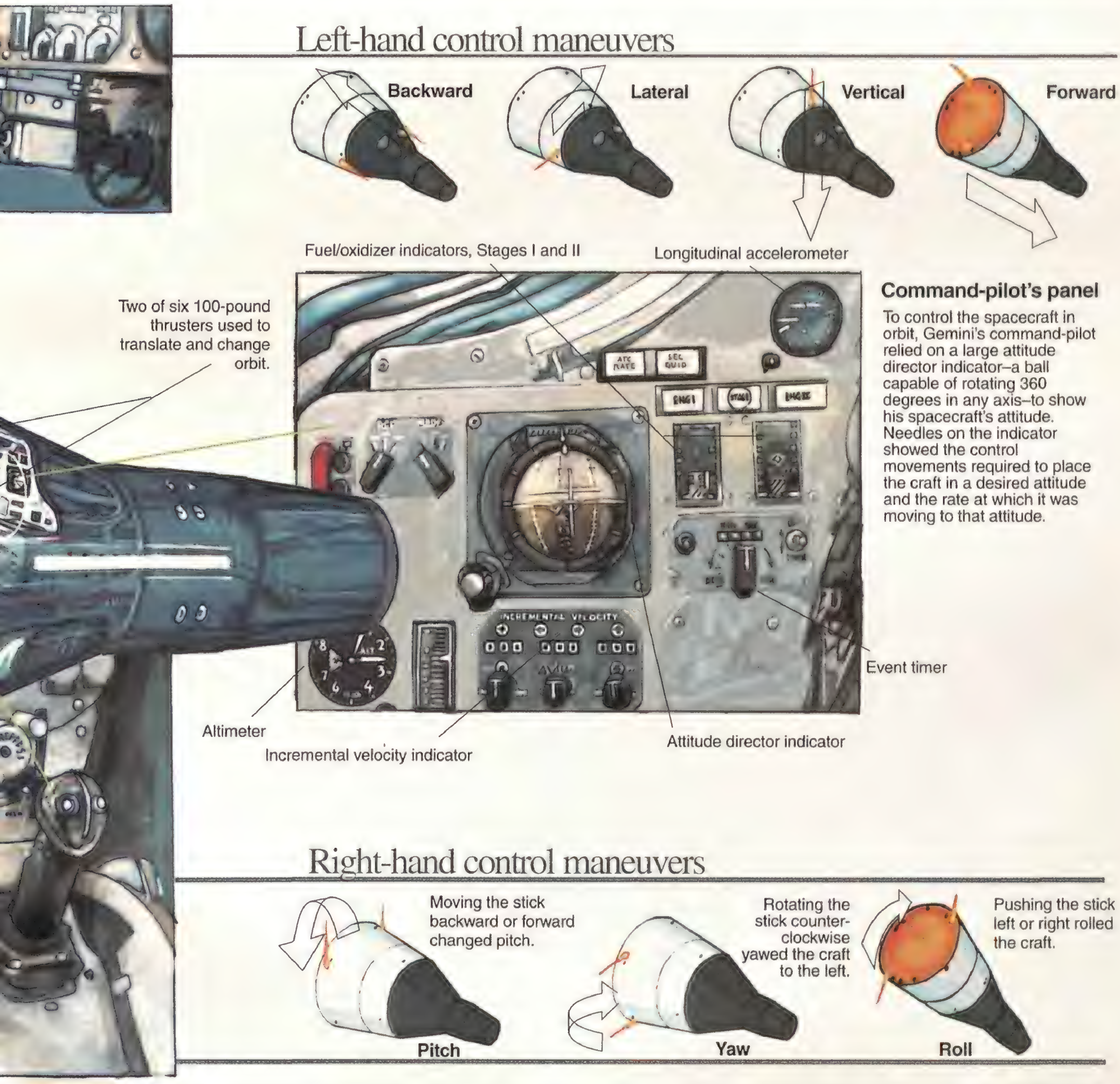
Right-hand controls

Gemini's pilots used the attitude hand controller, located in a center console, to pitch, yaw, or roll the spacecraft.

'Houston, Eureka! The world is really round,' and they rogered," Conrad says. "I didn't think much about the comment at the time—that is, until I got back to the astronaut office and got all these letters from the Flat Earth Society in which they explained to me that the earth was flat. But they did acknowledge that it was indeed disk-shaped."

The later Gemini missions brought the opportunity to try experiments not directly related to the upcoming Apollo missions—and to explore new piloting challenges. One of these procedures was designed to create artificial gravity in orbit. The idea was to connect two spacecraft of like mass (the Gemini and Agena) with a 100-foot Dacron tether. The astronauts were then to undock from the Agena, back away until the tether between the two spacecraft tightened, and then spin them up. The engineers said it would be easy.

"It was driving us nuts," Conrad says. "No matter how gently I backed the Gemini away, something like 1/10th a foot per second, that tether would translate it down the line and here would come the Agena bearing down on us. And it would start to drift and you would start to drift, and I'd try to drive the Gemini around and get it right and *uh-oh here comes the Agena* again and then *ba-bing* you're into night. I remember us going into nighttime and me won-



Command-pilot's panel

To control the spacecraft in orbit, Gemini's command-pilot relied on a large attitude director indicator–a ball capable of rotating 360 degrees in any axis–to show his spacecraft's attitude. Needles on the indicator showed the control movements required to place the craft in a desired attitude and the rate at which it was moving to that attitude.

dering *Where is this thing?* because it was chasing us and weighed about the same as we did. If it hit you that could ruin your whole day.

"Finally I said okay, I've got to take the bull by the horns and start thrusting aft. And as soon as we get to right where [the tether] is taut, I'm going to fire down and aft and just get her going. And sure enough that worked. We got her spun up and it was real neat. You could take a pencil and let go and then the thing would start to drift aft because we had something like 1.5 thousandths of a gravity going. It was squirrelly at the beginning but by the end we were so comfortable being spun up that we were actually able to have a meal. It was real seat-of-the-pants flying."

Averaging three or four days in length, the majority of Gemini missions were so jam-packed with flying and experiments that the astronauts could easily ignore the confining dimensions of the Gusmobile. But on two Gemini flights the confinement became almost unbearable. These were a return to the days of Mercury, where it was not piloting skills that counted but the ability to survive.

Of his experience as right-seater on the eight-day Gemini 5 mission, Pete Conrad says, "I call it eight days in a garbage can. The fact is you can't do anything. You can't go anywhere. You can't move and have no great desire to sleep because you're not doing anything to make you tired. You don't have anything to read and there isn't any music. Near the end of the mission, most of our thrusters had crapped out so all we could do was drift and, as the fickle finger of fate would have it, when we were over the ocean, that's when the spacecraft would be pointing down and all we'd see was the water. By the time it got to land, which is much more interesting to look at, that's when we would start pitching up and we'd be looking at black space.

"I spent half my life opening stuff up and re-wrapping it real tight so we didn't have garbage all over the cockpit. If it wasn't for that I would have probably shot myself because there was nothing else to do."

When Gemini astronauts compared the spacecraft to a hot fighter plane, they were referring to its handling characteristics, but they could have meant the vehicle's spaciousness (or lack of it). The Gusmobile's namesake (foreground) and John Young are shown just after insertion in the spacecraft for the Gemini 3 mission.

NASA

At almost twice the length of Gemini 5, Commander Frank Borman's Gemini 7 mission may have been even more trying, but it grabbed the attention of at least one Hollywood producer.

"Right after we got into orbit we were supposed to 'station keep' or fly formation with the booster," Borman says. "We were flying formation and taking photographs and infrared measurements and I started calling it a 'bogey,' which is an old fighter pilot term. Well, a lot of the UFO freaks on the ground picked this up and said we had seen a UFO because we had referred to our booster as a bogey....Just this past year I got a call from a producer at "Unsolved Mysteries" and they said, 'We read your account about your seeing a UFO on Gemini 7 and would you come on the program?' I told them: 'I'd love to come on your program because I'd love to straighten that out.' I explained what it was I saw and I said, 'I don't think there were UFOs,' and the producer said, 'Well, I'm not sure we want you on the program....' "

Particularly for Gemini's long-duration crews, working the hind end of the maxim "what goes up must come down" was a happier affair. To prepare for reentry, the crew activated the two sets of reentry thrusters ringing the Gemini's nose, turned their spacecraft blunt-end first, and explosively jettisoned half the white adapter section, revealing four solid propellant rocket motors. At a precise instant designated by both Houston and the world's first digital computer in a manned spacecraft, a 2,500-pound retrorocket exploded to life for 5.5 seconds, followed in quick succession by three others.

Dick Gordon had been in space for three days on Gemini 11 and thought retrofire was "nothing to write home about." But after 190 hours and 15 minutes of zero-G, retrofire was a real boot in the pants for Gordon Cooper: "I think [the retrorockets] only provide about one-half G of acceleration, but when they kick in, especially after eight days, they make you feel you are going to go around the world the other way."

As the Gemini began its long, shallow, half-hour dive into the atmosphere,

Two frogmen astride Gemini 6 await rendezvous with the USS Wasp. *The astronauts inside the Gemini, Wally Schirra and Tom Stafford, had recently accomplished another important rendezvous: the first in space, with Gemini 7. "Gemini was my favorite spacecaft," Schirra later said, "but it made a lousy boat."*

NASA

one last segment of adapter section was jettisoned, exposing the Gemini's heatshield. Using the reentry control system mounted in the spacecraft's nose, the command-pilot rolled the spacecraft 180 degrees, or "heads down," so that the horizon was visible in the upper portion of his cabin window. Over the next 10 minutes the crew members split their time between working the reentry checklist and grabbing final glimpses of the world from Earth orbit.

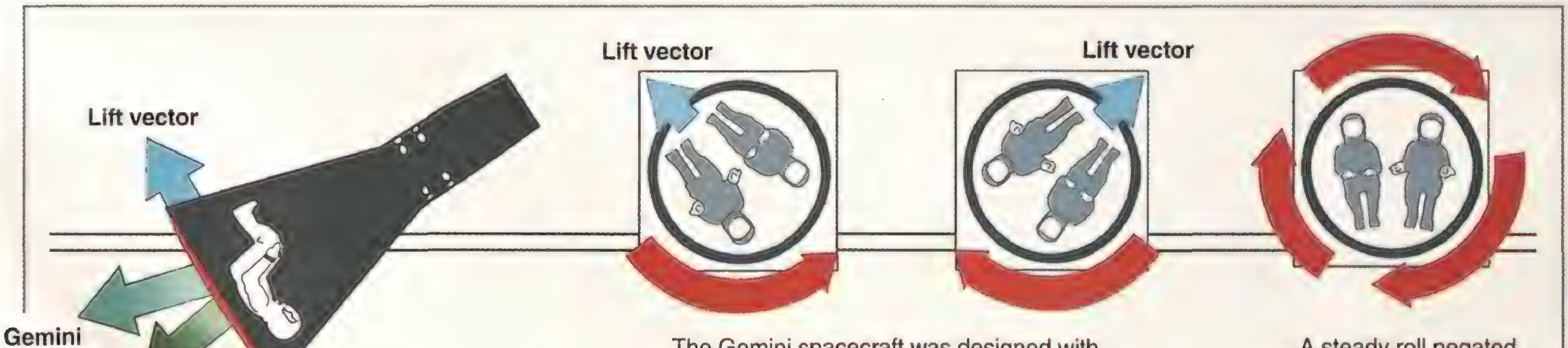
At 400,000 feet the Gemini descended into the first tendrils of upper atmosphere and an ion-induced light show began. Wally Schirra likened reentry to being at the base of a Bunson burner's flame. Frank Borman thought it was like "flying in a neon tube." John Young remembers the colors: "The first thing you notice is at about six and one-half minutes after retro fire a slight orange haze that envelops the spacecraft. And this haze layer increases and changes color to a dark green. It's a very beautiful thing. And then orange sparks of ablative material start flying forward."

Aesthetics aside, it was another moment of truth for the pilots of Gemini—not only for their survival but for the success of the future Apollo program. Plans for moon landings could proceed only if astronauts could control the lift of the spacecraft. Otherwise, crews returning to Earth at the high speeds associated with lunar distance might be crushed by the extremely high G-loading, land almost anywhere on the globe, or possibly bounce off Earth's atmosphere altogether.

During Mercury, reentry was a straightforward affair: a ballistic trajectory that could not be changed once the retrorockets were fired. But a Gusmobile's pilots could steer the beast—possible because Gemini, unlike the Mercury, had an offset center of gravity. This caused the spacecraft to move through the atmosphere at an angle of attack that gave it a modest amount of lift. The direction in which the lift acted is called the lift vector.

Gemini's engineers designed the mass properties of the spacecraft so that lift was created on the side of the craft opposite the hatches and windows, with the lift vector pointing toward the pilots' feet. The Gemini commander made corrections to his flight path during reentry by rolling the spacecraft and thereby changing the direction in which the lift vector was pointing. To steer the spacecraft to the left of its track, the commander rolled the spacecraft to his right, which pointed the lift vector to the left. Rolling the craft to the commander's left steered it right (see diagram below). Maximum lift—and, therefore, maximum range—was achieved by not rolling the spacecraft at all and flying with the astronauts positioned with their heads at the lowest point.

By manipulating the lift vector, Gemini crew members could change their splashdown point by up to 27 miles right or left of their line of flight and extend the landing point downrange by up to 300 miles. But if the spacecraft was



The Gemini spacecraft was designed with a lift vector pointing through the astronauts' feet. If the command-pilot rolled the craft in one direction he would rotate the lift vector in the opposite direction, manipulating the Gemini's flight path.

A steady roll negated the lift vector by distributing the force equally in all directions.

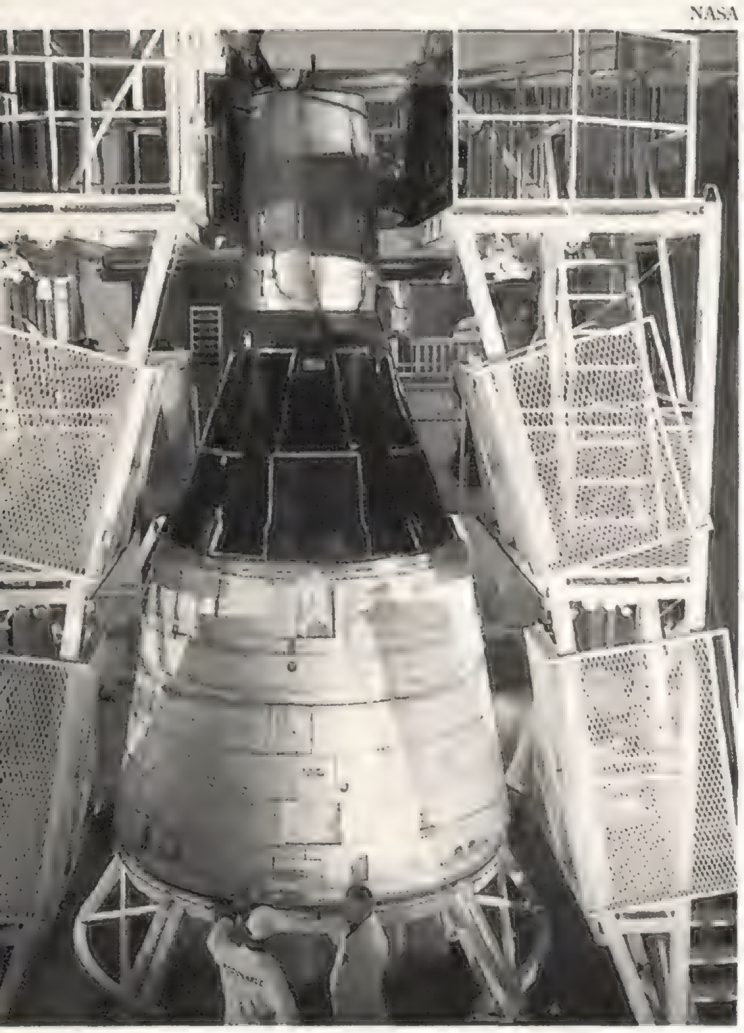
dead-on in its reentry, the astronauts could put the Gemini in a 15-degree-a-second roll, which negated the effects of the lift by distributing it equally in all directions.

Beginning at the same 400,000-foot altitude at which the light show started outside, the Gemini's computer began processing the information necessary to make these corrections by measuring information provided by onboard instruments and calculating the point of impact. Its calculations for downrange and crossrange errors—how far the actual flight path diverged from the intended one both lengthwise and laterally—were used to develop the commands for rolling the spacecraft, and these were transmitted by the roll needles on the attitude director indicators.

"From now on it was precision flying dictated by precision instrumentation, not unlike using an instrument landing system (ILS) to bring an airplane down in the soup," Frank Borman wrote in *Countdown*. "For most of the reentry, I couldn't see outside and just followed what the dials were telling me."

In its role as a testbed for proving the major concepts needed for a mission to the moon, the Gusmobile—here, Gemini 4, during a pre-launch check—was an unqualified success.

NASA



Over the next 10 minutes the Gemini descended to 100,000 feet. While the command-pilot was flying the spacecraft, his crewmate had little to do but monitor the computer and perform some backup calculations with charts and graphs. So with time on his hands and a surreal light show out his window, Gemini 12's Buzz Aldrin decided to become a filmmaker.

"We had a window-mounted 16-mm camera and I decided that during this reentry I was going to take the camera and hold it up against the window to get a really good view of the reentry plume," he says. "And I did that and we got some very good shots. But you can also see where the Gs built up it was hard to hold. You can tell that the camera does change its position. I let go and it slammed into my chest. But we got some pretty good pictures on that one."

By 40,000 feet the Gemini crew deployed a drogue chute, which further slowed and stabilized the spacecraft. At 10,000 feet the Gemini's 58-foot-wide main chute unfurled and the spacecraft pitched forward so its occupants could return to Earth upright.

"The Gemini splashdown was easy," Dick Gordon says. "You are sitting up, and I remember going submerged and seeing the change in the color of the ocean. And then you pop back up like a cork."

Moments later, as the nose-mounted reentry control thrusters hissed and smoked, each Gemini crew discovered two very important things about the Gusmobile. One was that the heatshield, which had so recently prevented them from being incinerated, was now acting like a frying pan, making the cabin uncomfortably hot and sticky. Wally Schirra describes the other: "Gemini was my favorite spacecraft," he says, "but it made a lousy boat."

While Gemini was making crews seasick, NASA was building the next generation of spacecraft, one that would fly beyond Earth's orbit. That too was a stunning accomplishment, but the Apollo craft that would take us to the moon was more of a transport—not the hot and nimble fighter that was the Gusmobile.

Riding the Titan II

Once the Gemini's hatches were closed and locked just before launch, the busy throng that readied the spacecraft for orbit diminished dramatically—to two men and a machine that smelled slightly of plastic, sitting on top of a 150-ton intercontinental ballistic missile. Riding the tip of a 100-foot burning cylinder whose useful life is less than your average Marlboro is something you don't forget, even after three and a half decades.

Recalling the launcher that powered all 10 manned Gemini spacecraft into orbit, two-time Gemini astronaut Pete Conrad says: "The thing about the Titan that I remember was somewhere in the count, like at T-minus-30 seconds, they open the oxidizer pre-valves. The oxidizer was all the way up in the tank, and that line runs all the way down through the fuel tank down to the base. So when they opened that thing up, you are sitting on top of this thing—you are not that far away—and you can hear it going *glah-glah-glah-glah*.

"The Saturn V was a great big hulk, you know," he says of the enormous launcher behind the Apollo moon missions, "and the engines are 365 feet away and you don't hear a lot of things happening. But the Titan wasn't that big. You can even feel it sway a little bit in the wind. I'll always remember that oxidizer pre-valve at 30 seconds. When you heard that you knew they were serious about sending you somewhere."

At the time it was chosen for Gemini duty, the Titan II was the most powerful rocket in America's inventory. An improved version of the Air Force's Titan I, it first flew successfully in March 1962. Unlike Project Mercury's Redstones and Atlases, as well as the later Saturn Vs, the Titan used room-temperature propellants called hypergolics, which ignite on contact. At T-minus-0, an electrical signal set things in motion by igniting two small cartridges in the Titan's two first-stage Aerojet engines. The gas from the cartridges started the Titan's turbopumps spinning, which in turn forced both fuel and oxidizer into the engine's combustion chambers. When combined, the hypergolics emitted only a relatively small white flame

and a rosy cloud rather than the burst of orange flame and billowing smoke of Mercury and Apollo launches. Four seconds later, if all systems remained go, the bolts that anchored the Titan to the launch pad exploded and the Titan was on its way.

At least that was the scenario the Gemini astronauts expected. On December 14, 1965, Wally Schirra and Tom Stafford heard the pre-valves open, the turbopumps whir, and the Titan begin to rumble with the power of 430,000 pounds of thrust. All indications were that Gemini 6 had lifted off from Pad 19—when the engines inexplicably shut down.

"A light came on in the spacecraft saying we had liftoff," Schirra says. "I heard from the blockhouse that the clock had started, which means we had lifted off. But I knew we had not lifted off. It was a gut feeling. Stafford didn't know what was going on but I had the experience of a Mercury flight and my butt told me we hadn't left the pad."

Schirra's butt was right. A small electrical connector had vibrated loose a split-second before launch, sending a spurious shutdown signal to the Titan's first-stage engines. Had the Titan actually left the pad before engine cutoff, the missile would have toppled over, engulfing Schirra and Stafford in flames. If so, their only chance at survival would have been the Gemini's untried ejection seats.

Recalling the final Gemini mission, Gemini 12, Buzz Aldrin says, "There was no doubt in Jim Lovell's and my mind when we lifted off. Our bodies knew it. We could feel the acceleration straight off. The Saturn V was different. It had a much lower thrust-to-weight ratio and it didn't accelerate as well. When we came back from Apollo [11] and debriefed, we all agreed that we couldn't identify liftoff except for the instruments and the audio transmissions. But on Gemini we knew."

"Saturn V is an old man's ride," says Dick Gordon, who flew on both Gemini and Apollo missions. "There is a lot more shake-rattle-and-roll going on with the Saturn V because it is so much longer. And it's got three stages and is more flexible in its longitudinal axis.... As opposed to the two [stages] on the Titan—which was a young fighter pilot's ride. It's faster. It's dynamic. The forces involved are greater."

Both Schirra and Gemini 5 astronaut Gordon Cooper agreed it was a smoother ride than the liftoff on their previous Mercury flights, which had been launched by Atlas rockets. "The Titan had a thicker skin than the Atlas," Cooper says. "The Atlas was literally a gas bag. Its skin was so thin it had to be pressurized to hold its shape. I remember going up the gantry for my Mercury flight and seeing the skin of the [Atlas] flexing. When you take that flexible skin and you launch it you get more oscillations, kind of like being on the end of a Slinky."

NASA

What sticks out in Frank Borman's mind about his ride aboard the Titan that launched him on Gemini 7 was the sound. "The Gemini simulators we trained on were extremely realistic and prepared us for all the sensations of liftoff—except the noise," he says. "Even in our insulated cabin, over 100 feet away from the engines, the sound was almost deafening. It started right off the bat at liftoff and sounded like a large jet in afterburner or a large freight train bearing down on you."

Two and a half minutes after launch, the Gemini-Titan stack was 50 miles high, traveling 6,700 mph, and, with its two first-stage engines gulping 1,600 pounds of propellant every second, had already shed over three-quarters of its launch weight. The crew members were being pressed into their ejection seats by nearly six times the force of gravity when suddenly the acceleration dropped off.

"Staging is really something," says John Young, who flew on Gemini 3 and 10. "It's called 'fire in the hole' because you fire the second-stage engine before you get rid of the first stage. [It] blew out everything and fire came all around the vehicle and you could see it. That was a surprise to me. But it is only momentary, and with the second stage firing you get right out of there."

"That second stage surprised me," Dick Gordon says. "On Apollo, the third stage of the Saturn V got to altitude and then *chug-chug-chug* at about half a G until it got the right velocity and shut down. Well, on Titan both were done simultaneously. And near the end, you've got 100,000 pounds of thrust pushing an almost empty stage and a lightweight Gemini spacecraft. It was startling how fast the G-forces built up. I said *Man, how long is this sucker gonna keep a-running?* I tell you I was ready for the second stage to quit about the time it did. And cutoff was a great transition. I mean, you're going from 7 Gs to zero Gs just like that. Soon as that engine cuts you are thrown up against the straps just like on a carrier landing."

At SECO, or Second Stage Cut Off, the Gemini was 100 miles high and 531 miles downrange. Twenty seconds and 90 miles later, the command pilot reached a now-weightless hand toward the left side of the center panel and pressed a button marked SEP SPCFT. In an instant, mini-guillotines fired, severing electrical connections between the Gemini and its booster, while two rings of a flexible charge encircling the base of Gemini's white adapter section detonated, literally ripping the two machines apart.

"I was getting my first view of space," Gordon recalls. "I said, 'Holy shit! We just blew up!' Pieces and parts of all the explosive stuff, washers and bolts, were floating in a cloud all around us. It wasn't anything that could puncture the Gemini but it was fascinating to watch all the junk that came out. Pete [Conrad] sees it too, sees me seeing it, and says, 'Get to work, Dick.' We didn't have time to look around. We had to go right into our onboard calculations."

Out to PASTURE

AFTER ITS HONORABLE DISCHARGE, THE DE HAVILLAND CHIPMUNK STILL HAS A FEW LOOPS LEFT.

by Michael Dempsey

Photographs by Michael Freeman

In a field six miles from the coast of southern England, members of the East Sussex Gliding Club are dragging their aircraft back to the hangar in heavy rain. The grass runway is criss-crossed with muddy channels created by glider skids, and some of the aircraft are already staged on a narrow apron in front of the hangar. Now the pilots begin the difficult task of jockeying their gliders back into the limited space inside the building.

The hangar starts to resemble a giant toybox. At the very back, a single powered aircraft is wobbled to and fro as Terry Henderson, a Concorde captain for British Airways, issues instructions to teenage gliding enthusiasts. The aircraft getting all the attention is painted bright red and white and bears the insignia of the Royal Air Force. It is a 46-year-old de Havilland Chipmunk, designed in Canada, manufactured at Chester in northern England, flown by countless pilots-in-training during its years of military service, and now enjoying a new career as a glider tug on the U.K. civil register.

It is undistinguished in its new job. "It's noisy and underpowered," says Henderson, its owner, "but it's suitable." Henderson gets free hangar space in return for lifting gliders into the damp Sussex sky on weekends when the timetable of supersonic transatlantic operations allows. Fresh from training on the Concorde simulator at British Aerospace's plant in Filton, Henderson responds to questions about Mach 2 commercial operations with the emotional detachment for which airline pilots the world over have become renowned. But if you turn the conversation to Chipmunks, he becomes sentimental. "It's the most beautiful aircraft, a real honey to fly," he says. "My club can't afford a dedicated tug. But they needed something, and I needed an excuse to fly my Chipmunk."

The airplane occupies a special place in the hearts of British pilots, maybe because, for almost all of them, it was their first. It was the RAF's primary trainer between 1949 and 1973, after which it was gradually replaced by the Scottish Aviation Bulldog. But it continued to fly in RAF-sponsored training programs until 1996.

The first Chipmunk flew from the de Havilland Canada plant in Toronto 50 years before. It used the same 1930s-vintage, 145-horsepower Gipsy engine as the Tiger Moth biplane it was built to replace. De Havilland in the U.K. was heavily occupied with other projects at the end of World War II and handed the design and initial production of the trainer over to the Canadian side of the company.

What resulted was a rugged, all-metal, low-wing tail dragger perfectly at home on a grass strip. Often operating from the corners of larger airfields, Chipmunks trained members of all three British armed services, as well as His Royal Highness the Duke of Edinburgh and his son Prince Charles. The little de Havillands also enchanted generations of non-royal civilian pilots through two British institutions. The first, the Air Training Corps, is a sort of British ROTC of the air, which introduces young people from 13 years of age upward to

One of the 96 Royal Air Force trainers sold for civilian use since 1994, Alan Tipper's perfectly painted Chipmunk gleams silver over Wycombe Air Park, near London.

British Airways captain Terry Henderson (top) flies the Concorde for a living and the Chipmunk for fun. A University of London Air Squadron badge (above) proves the pedigree of Alan Tipper's new toy (opposite, top).

the basics of military flying. The highlight of ATC life is a trip into the sky with Air Experience Flight, which, until 1996, flew Chipmunks. The second is a network of 16 government-sponsored University Air Squadrons, units that sign up older students interested in a flying career. The ATC and UAS placed a nation of novice aviators in Chipmunk cockpits, and, whether they went on to military service or not, hundreds of them show up to see the airplane at airshows, and a few, like Henderson, bought their own.

Henderson got his first flight in a Chipmunk in 1957, when he was still in high school. He met up with the de Havilland again at a civilian pilot training school he attended—Hamble, near Southampton—where students flew the two-seater to practice, among other skills, navigation and instrument flying. During instrument training, two students flew the Chipmunk; the one in the front seat wore a hood that restricted his vision so that he could see nothing outside the cockpit, only the instruments in front of him. "You had to do what you were told by the second guy, who we called the 'safety pilot,' " says Henderson. "The idea was to prepare you to cope with unusual attitudes while flying on instruments. The backseater would throw the Chipmunk about and you then took control and had to recover level flight using the instruments."

In the first few sessions the backseater would perform a few aerobatic maneuvers to disorient the guy in front, then turn the aircraft inverted and hand it over. The frontseater, referring to his instruments, would set it right side up. Eventually the backseater would trick his man by flying a few maneuvers and then handing over control while flying straight and level. Henderson says the confused trainee would invariably invert the aircraft.

Hamble may have been a civilian establishment, but in at least one situation, the trainees there used the Chipmunk as an instrument of war. Henderson remembers that one of his fellow students was courting the daughter of the local bishop, who strongly discouraged the romance. The Hamble student body pulled together and retaliated on behalf of their friend by flying mock dive-bombing sorties on the poor man's house every chance they got.

The Chipmunk was enough fun to fly—for reasons other than the opportunity to harass the bishop—that 37 years later Henderson joined the crowd in an auction room in London's Bond Street and bid for an ex-RAF Chipmunk with 11,800 hours of recorded flying time. It cost him £12,431 (about $20,600). Henderson's bank manager is part owner of a Consolidated Catalina flying boat, and Henderson believes this shared appreciation of classic aircraft helped smooth the way for a large check to be honored.

The U.K. Ministry of Defence sold 96 Chipmunks at auction between January 1994 and May 1997. But according to the pilots who are seeking them, the urge to fly one again is not due solely to nostalgia. "It's a remarkable airplane," says Tony Cowan, a 52-year-old retired RAF officer who spent his career flying the Nimrod, a four-engine maritime reconnaissance aircraft derived from the world's first jet airliner, the Comet. Cowan flew the Nimrod on the longest British mission of the Falklands War, a 19-hour patrol.

"The Chipmunk is well balanced, well harmonized," says Cowan. "It can bite, like any good aircraft. There's a saying: It's not a difficult aircraft to fly, but it's quite a difficult aircraft to fly well."

Cowan would be a good judge. Last summer, he and two other RAF pilots—Ced Hughes, 63, and Bill Purchase, 60—flew two Chipmunks on a nine-week trip around the world. Cowan quips that "you had to be as old as the aircraft" to participate. Theirs were the first Western light aircraft to fly in Russia east of the Ural Mountains.

The objective was to find a new air route from the U.K. to North America that avoided the difficulties of the traditional passage, says Cowan, which crosses the stormy North Atlantic and the arctic wastes of Greenland and Canada. So the pair of Chipmunks, backed up by a chartered twin-engine Britten-Norman BN2A8 Islander, flew east from London, instead of west, traveled the length of the longest country in the world, and exploited the short sea crossing over the Bering Straits. A Russian officer, Major Yuri Vostroknutov, flew with them in the Islander as local liaison east of Moscow.

Each Chipmunk was modified with a 24-gallon fuel tank in place of the back

seat. With 42 gallons of fuel in all, the aircraft's range was extended from 200 to 500 miles, and the two RAF trainers hopped across the 5,000 miles between Moscow and the Bering Straits, cruising at 100 mph and 5,000 feet.

Airfields consisted of compacted earth or gravel, and the expedition parked nightly in the company of other robust survivors, the Antonov An-2 multi-role biplane and the twin-engine An-12. Their arrival always caused a sensation. "People surrounded you," Cowan recalls. "Suddenly there would be a large group, and you'd always find one who spoke English. On about six occasions a TV crew would turn up. People were very curious about the fact that British pilots were in the middle of Russia." At Lensk in Siberia they returned to the aircraft one morning to find a set of pilot's wings attached to the Islander and a note in English reading "Good luck."

After a seven-week flight around the world, RAF squadron leader Tony Cowan returned this Chipmunk to RAF Newton. The tour over, both Cowan and the aircraft retired from active service.

The Chipmunks performed gallantly. Even when Cowan and his companions had difficulty finding aviation fuel and used automobile gas instead, the Gipsy engine didn't seem to notice, says Cowan. On the home stretch across North America, the pilots dropped in on the Chipmunk's birthplace, de Havilland Canada in Toronto. There they met George Neal, one of the original test pilots of the DHC-1, who was impressed that the aircraft was now exerting itself on a 16,000-mile trip.

Cowan believes the Chipmunk was a good choice for the adventure, not only because of its hardiness but because the flight reflected the pioneering spirit of the 1930s, when, with basic equipment like the Gipsy Major, aviators tested and explored. "This was not a flight down memory lane," he says. "It was real expeditionary flying. We proved that there is a safer route for

ERIK HILDEBRANDT

general aviation single-engine fliers."

I first met Cowan before his round-the-world flight, in April 1996 at Cambridge Airport, where he was flying Chipmunks with the Air Experience Flight stationed there. Number 5 AEF occupies a series of low brick buildings on the northwest corner of the field, and, like the other 11 AEF units in the Royal Air Force, exists solely for the purpose of finding people who want to be pilots when they grow up. On that Sunday, the prospects were teenagers who had arrived by the busload from London and its eastern suburbs. They were perched on chairs outside 5 AEF's offices, waiting for a 25-minute flight in the back seat of a Chipmunk with some RAF Phantom or Jaguar or Nimrod pilot who would instruct them in simple maneuvers.

Like all the instructors, except the AEF flight commander, Cowan had volunteered his time that Sunday, part of about a hundred hours he contributes over the course of a year. His motivation, no doubt, includes the desire to pass along what was given to him: His first flight, when he was 14, was with AEF in a Chipmunk.

"It's a crude sort of filter to find the ones really interested in flying," says Cowan, "but it must save the air force a lot of money just limiting the number of washouts later on.

"You can usually tell the ones who want to fly right away," he adds, "especially when you see one coming back for a second shot the same day."

That afternoon Cowan took one flight away from the youngsters to offer me a ride, and I followed the path of thousands of prospective British air crew, sitting on the bulky parachute that doubles as a cushion in the spartan rear cockpit of a Chipmunk. Nine instruments faced me on the worn black panel. With low headroom and rudimentary instrumentation the aircraft felt like a well-loved if outdated sports car that has passed down through family hands. Ably supported by its anachronistic tail wheel, the Chipmunk trundled across the grass toward the tarmac of Cambridge's main runway.

As we clambered toward 4,000 feet, I remembered my own youth in northern England near a very small air base occupied by Chipmunks. The Gipsy engine was part of the landscape, humming gently through the summer months when flying hours were long. New arrivals in town always betrayed their greenhorn status by halting, looking up, and searching the sky for imminent disaster when a Gipsy engine suddenly fell silent. We natives knew better. A Chipmunk looping always cuts out for a few seconds before recommencing its gentle buzz. "It had no inverted system," explains Terry Henderson, and the fuel flow was momentarily halted during any negative-G maneuver.

Twenty-five years later I finally got to feel that loop from the inside, as Cowan picked up speed in a dive and then sent the Chipmunk climbing back over its own tail. In the tiny rear cockpit G-forces pressed firmly on my shoulders, the earth appeared in the canopy roof, and my stomach felt as though it had dropped through my feet. With that one exhilarating maneuver, the Chipmunk has determined the careers of countless air crew.

Still, not everyone connected with the RAF is mourning the Chipmunk's retirement. In a huge Cambridge airport hangar owned by Marshall Aerospace, the company that services the RAF's fleet of Lockheed C-130s, Marshall employee Martin Smukums is surrounded by aircraft in various states of repair. Marshall is a civilian contractor that supports the Cambridge AEF.

A Chipmunk sits under one vast skylight with its tail section removed and engine panels splayed open. Oil trays are spread under a fuselage peppered with rivets, and Smukums is extracting components from a grimy Gipsy starter.

"It's very basic, very simple," Smukums allows, "but the parts are wearing out and it's a very dirty engine to work on. In one way I'll be glad to see them go...but it's a shame too."

One component that few Chipmunk fans will miss is the curious system that started the engine. RAF Chipmunks exploded into life with a bang and a strong smell of cordite from the six-barrelled breech, or cylinder, which the pilot triggered to fire. An exploding shotgun shell from the breech increased pressure behind a piston that drove a spiral gear. The gear turned the propeller. An alternative is to give a strong yank on the propeller to start the engine, an inconvenient—not to mention limb-threatening—process.

Terry Henderson remembers the ordeal of trying to get the Chipmunk started during his flight training days. "The complexity of getting all the commands correct, switches in place, and priming of the engine [done externally by the mechanic] often led to cartridges being spent needlessly in a vain attempt to start," he says. "This would increase the instructor's criticism of the poor student, who always felt on the brink of utter failure."

Henderson had his Chipmunk modified with an electric starter, a conversion required by the British Civil Aviation Authority. But when he first picked up the Chipmunk after buying it, the CAA provided him with a one-flight ferry permit and a single shotgun cartridge, which gave him one shot at starting the engine. Fortunately, he got it right the first time.

The CAA also requires demobilized Chipmunks to undergo a formal inspection of the undercarriage struts because of an unfortunate slip in the 1950s, when a batch of struts crept out of the factory with inferior metal. The RAF seems uncertain as to whether they were attached to any operational aircraft, and the CAA is not willing to take any chances on a brutal landing. Henderson also replaced military "Velocity Never Exceed" placards with civilian ones, which warn pilots never to pass 178 mph, the speed at which the aircraft could fail structurally.

As the modifications were being made, a new flight manual was issued from British Aerospace, the corporate resting place of the de Havilland name in the U.K. At £420 (almost $700) this was an expensive but essential requirement to gain the CAA's Certificate of Conformity, which entitles demobilized Chipmunks to fly again. In May 1996, on his first flight after the auction, Henderson flew his Chipmunk to Windmill Aviation in eastern England. It wasn't until October 25 that he could fly it away to the gliding club in the south. And while the aircraft was being updated, the pilot also had to be checked out.

CAMERON DAVIDSON (2)

Chipmunk diaspora: Over White Bear Lake in Minnesota, the latest addition to Wally Fisk's fleet holds straight and level. In West Virginia, Chipmunk owner Jake Wilburn and Marcos Jimenez (right) work with Richard Tucker (below) to install the newly rebuilt bottom end of a Gipsy Major inline inverted engine.

Henderson chose fellow British Airways Concorde veteran Tim Orchard to accompany him and sign off on his Chipmunk type-rating test. Orchard, who spent seven years flying the Concorde and has just converted to the Boeing 777, manages the British Airways Flying Club, which resides at Wycombe Air Park, west of London. He also bought a retired Chipmunk, in partnership with another British Airways pilot, Ian Barlow, who flies Boeing 737s. "Its pseudo-military handling qualities are beyond reproach," says Orchard. "Your warning of a stall comes in the way of gentle buffeting and nose drop. That's ideal for students who need to develop skills [before they move on to] unforgiving aircraft."

Orchard's Chipmunk spent the first six months of its working life, in 1951, at the same air park where it flies to-

day. Then the park was an RAF station called Booker. Today the Chipmunks have returned in strength. Wander into any of the field's hangars and you will find an ex-military Chipmunk slotted between the wings of less colorful aircraft. Nine of the veterans currently fly at Wycombe.

Barlow perches on the wing of the aircraft he shares with Orchard and points out modifications. Leather seats were installed in place of the utilitarian metal ones that had made a parachute a requirement of personal comfort as well as safety. A white GPS antenna on the engine cowling brings satellite navigation to the Chipmunk, although the original chunky metal compass still sits on the floor between the pilot's feet "like something that belongs in a ship," as Barlow puts it.

Alan Tipper, 64, a personnel executive in London's corporate jungle, also keeps his immaculate Chipmunk at Wycombe Air Park. Tipper flew Chipmunks with the University of London Air Squadron. After graduating he was called up for his national service, eventually flying another de Havilland classic, the tiny twin-boom Vampire jet fighter. He had recently renewed his pilot's license after a 16-year break, and when he heard that the RAF was disposing of its Chipmunks at auction, he made a decision that led him to a showdown at a London auction house. "There were four people bidding for my Chipmunk," he says. "I let them fall out one by one until the price hit £16,500 and one guy was left." He stood firm against an Italian consortium until the Chipmunk was his for £18,000 (almost $30,000).

Tipper took ownership of the aircraft in June 1996, flying it over the summer before arranging for a paint job during the winter months. He commissioned an exact copy of the paint scheme worn by Chipmunks he flew as an enthusiastic science student contemplating RAF service. Through the RAF Museum in London and the service's historical branch, Tipper found a 1950s Air Ministry order stipulating Chipmunk colors for the day. Unlike many Chipmunks flying in military colors, Tipper's is painted matte silver with yellow bands on the fuselage and wings, a finish that marked all RAF trainers in the 1950s.

To get the precise details of his former squadron's badge, Tipper visited the squadron's new base, Benson in Oxfordshire. Then he flew his prize up to Benson for the squadron's open house. "Old members were thrilled to bits to see a Chipmunk in perfect '50s colors," Tipper says.

Relaxing in the Wycombe Air Park bar after clambering from his 45-year-old aircraft, Tipper explains why flying the Chipmunk is so much fun. "It's a super plane," he says. "I've been able to get back into aerobatics again. One quickly feels at one with it. The compact little cockpit means you don't have to think too much. It must be 40 years since I did aerobatics, but it all comes back so easily. The range is not too far—it gives you two and a half hours at 95 knots [105 mph]—but it's delightful to fly and extremely forgiving."

The Chipmunk's facility for aerobatics is what has made it famous in places other than the U.K. Most Americans know the airplane from the airshow act of Art Scholl, an aerobatic virtuoso and Hollywood stunt flier who thrilled audiences with inventive, razor-sharp performances, which he flew in a modified Chipmunk with his little dog Aileron on his shoulder. Scholl, who died in 1985 while performing a stunt for the movie *Top Gun*, had clipped 18 inches

off each wing of his two-seat Chipmunk and replaced the Gipsy engine with a 260-horsepower Lycoming. The aircraft is in the Experimental Aircraft Association's Air Adventure Museum in Wisconsin. His modified single-seat Chipmunk is in the National Air and Space Museum storage facility.

A number of Chipmunks drifted across the Atlantic into the hands of U.S. buyers when the RAF Reserve Flying Schools closed in the 1950s and their Chipmunks became surplus. Another exodus started in the '70s when the Bulldog started taking over RAF primary training duties. And after the most recent string of auctions, more Chipmunks will be showing up at U.S. airshows.

Aircraft collector Wally Fisk, whose fleet of 40-odd airplanes, mostly retired warbirds, is based at Anoka County Airport, Minnesota, acquired a Chipmunk last fall. The chief pilot for Fisk's operation, Ed Erickson, says the Chipmunk handles just like U.S. 1940s primary trainers, Fairchild PT-19s and -23s. He also calls it "a typical British airplane—terrible to work on, delightful to fly. It doesn't have any bad habits, but the controls are very sensitive. Don't ask it to do something you don't want it to do, 'cause it will do it."

Robert "Jake" Wilburn, owner of Air Corps Services, Inc., a West Virginia company that crews and maintains corporate aircraft, bought his Chipmunk from a friend a few years ago. Wilburn also had his Chipmunk modified with an electric starter. "There's 'antique' and there's 'lousy,' " he says with a laugh. "We were getting too durned old to hand-prop that thing."

Wilburn flew his Chipmunk to a few fly-ins last summer and says he stirred up some interest in the airplane. As Tony Cowan discovered in Siberia, the Chipmunk is a great device for meeting other pilots. "You always attract attention," he says. "People like to know the history and the background of the aircraft."

In November 1995 Terry Henderson piloted the first Concorde to land at Tucson, Arizona. Taxiing across the tarmac, he was directed to a parking spot near the perimeter fence, allowing the public a good view of his distinctive jet. Right next to his Concorde was a U.S.-registered Chipmunk in perfect RAF colors. "There were four air crew on that Concorde," Henderson recalls, "and we had all flown Chipmunks." Within 30 minutes he was airborne with one of the airplane's two owners, Paul Conn, flying low circuits over Davis-Monthan Air Force Base.

Club president Tim Orchard stands in a lineup of Chipmunks owned by members of the British Airways flying club (left). In one of the trainers, Alan Tipper (above) has returned to an old hobby: aerobatics. Terry Henderson's Chipmunk is still a working stiff, however, towing gliders over the English countryside.

Big Naval Battle in Solomon

Herald CHICAGO American

FLA
EDIT

RICKENBACKE
FOUND ALIVE

…a Arrives in City

EXTRA

Battle Nazis for Airport at Tunis

Big Naval Battle in Solomons

…air corps stations on army morale assignment for Secretary of War Stimson. (AP Wirephoto from Paramount News.)

Illini, Ohio Title Clash

Looks at Dead Dog--It's Her Son

THE WEATHER

Picked Up … Sea by U. S. Flying Boat

(Compiled from International News Service and Associated Press dispatches)

WASHINGTON, Nov. 11. Capt. … Rickenbacker, World War I flying … death-cheating traveler on the world … lanes, has been rescued by the navy … rubber lifeboat on which he had … around in the South Pacific Ocean si… plane was forced down at sea, Oct. … navy announced today.

"Rick" was picked up at sea with two of … ing companions by a Catalina flying boat … north of the Samoan Islands—peace time air … Clipper ships on their route from Honolulu to Australia.

Three other members of Rickenbacker's flight … rested on a small island, the announcement said … navy medical officer has been flown …

All But 1 Found Alive

Thus, all but one of the eight men … was forced into the sea while on a secret mission … south Pacific war theater for Secretary of War S… have been found alive.

Capt. Rickenbacker revealed the eighth man … Alexander Kaczmarczyk of Torrington, Conn. … eral days ago and was buried at sea.

Miss Victory

The Rescue of Eddie Rickenbacker

During World War II, the nation was transfixed by the search for a lost war hero and his crewmates. The end of their ordeal was a victory on the homefront.

by W. David Lewis

On October 21, 1942, a Boeing B-17 on a secret wartime mission vanished while crossing the Pacific. The aircraft was carrying eight men, including one beloved by the American public: Eddie Rickenbacker, whose exploits as a combat pilot in World War I had made him America's Ace of Aces. Rickenbacker's disappearance, his ordeal awaiting discovery on a small rubber raft in shark-infested waters, and his dramatic rescue three weeks later made for one of the biggest news stories of 1942. People who remember that era recall vividly his victory over almost certain death. I was a boy growing up in central Pennsylvania, and I will never forget the joy I felt when I heard that he was alive.

Rickenbacker and three fellow castaways later wrote detailed accounts of their nightmare, but when I began to study the episode, I learned there was much that had never come to light. During my term as the National Air and Space Museum's Lindbergh Professor of Aerospace History, I spent months in 1993 and 1994 going through 130 boxes of Rickenbacker's papers at the Library of Congress. When I returned to my teaching post at Auburn University in Alabama, I gained access to more fresh material, including 26 scrapbooks that Rickenbacker had kept and an unpublished account of the raft episode that he had started writing soon after his rescue and finished after his return to the States. I also had candid conversations with one who was actually there: castaway John Bartek. Rickenbacker himself had died in 1973, but I was able to talk with his only surviving son, William F. Rickenbacker, and, after William died, his widow Nancy, who helped Auburn acquire major collections of Rickenbacker-related papers. Among the published sources I consulted were *Old Soldiers Never Die* by Geoffrey Perret and *Rickenbacker's Luck* by Finis Farr.

It was Farr who had uncovered the real purpose of the mission Rickenbacker was on when his airplane went down. The mission had begun a week earlier, when Henry L. Stimson, Secretary of War under Franklin D. Roosevelt, decided to send a highly sensitive message to Douglas MacArthur, commander of Allied forces fighting the Japanese in the southwest Pacific.

At the time, MacArthur was both greatly venerated and greatly despised. At home he enjoyed the admiration of many Americans, partly because of his own efforts at self-promotion and partly because President Franklin D. Roosevelt and the War Department had, for propaganda purposes, collaborated in building up his reputation as a military genius.

But in the military, many loathed him. Stimson, for one, considered him disrespectful. In a conference with Army Air Forces chief Henry H. "Hap" Arnold in September 1942, MacArthur harshly criticized the Roosevelt administration's plans to invade North Africa as "a waste of effort" and called the existing defense system in the Pacific "old and out of date as a horse and buggy." When Army chief of staff George C. Marshall said that MacArthur would have to divert bombers from New Guinea to Guadalcanal, MacArthur responded with what historian Geoffrey Perret called "a farrago of

COURTESY AUBURN UNIVERSITY ARCHIVES (2)

Initial reports about Rickenbacker (right, shortly after the rescue) and his crewmates gave Americans an invigorating blast of good news, and for a moment, the war seemed to fade into the background.


NASM

empty threats and surrealistic demands."

Stimson wanted to put an end to MacArthur's criticisms, but that wasn't going to be easy. Roosevelt, who had once called MacArthur one of the two most dangerous men in America (the other being Louisiana senator Huey Long), was happy to keep the embittered general at arm's length in the Pacific, especially since MacArthur was contemplating a run against Roosevelt in 1944. Furthermore, given the admiration Americans felt for MacArthur, FDR could not very well take away his command. There was thus not much Stimson could do about MacArthur, but he could at least try to muzzle his criticisms with a reprimand—though it would have to be done privately. Stimson decided that he would not even put it in writing; instead, he would find an emissary on whose discretion he could rely. Rickenbacker was ideal.

The Ace of Aces had a razor-sharp tongue and a legendary ability to dress people down. He already had a problem with MacArthur, who had angered him in years past by making condescending comments about air power. And he was a civilian, and therefore impervious to MacArthur's military power.

Rickenbacker had long projected an energetic confidence. During the first world war he had gone to France as a driver on General John J. Pershing's staff but had persuaded military officials to post him for flight training. By the end of the war he commanded the famous 94th ("Hat in the Ring") Pursuit Squadron and in less than six months had shot down 26 German aircraft. After coming home in 1919, he was cheered by millions in a coast-to-coast tour.

Eventually, Rickenbacker began pouring his energy into commercial aviation. Taking charge of a faltering enterprise, Eastern Air Lines, late in 1934, he swiftly transformed it into the most profitable carrier in the sky. To legions of admirers, he symbolized what made America great.

Stimson summoned Rickenbacker to Washington on October 13. According to Perret's book, Stimson had decided to keep his reprimand from Marshall, with whom he normally shared everything. Closing the door to Marshall's office, which adjoined his own, Stimson whispered his words to Rickenbacker, warning him not to reveal them to anybody but MacArthur as long as he lived.

In later years, Rickenbacker apparently did recount the message to a confidante, most likely his son William. Finis Farr, who had relied heavily on William in researching *Rickenbacker's Luck*, reported that Stimson's reprimand went as follows: MacArthur was to stop being disrespectful of Marshall, accept Allied strategic decisions, get along with his rival, Admiral Chester Nimitz, and quit making critical statements in public.

On October 17, accompanied by Colonel Hans Christian Adamson, an aide from the Army Air Forces reserve, Rickenbacker set off from New York to California. The following day they would fly to Hickam Field, outside Honolulu. Their route ultimately was to bring them to Brisbane, Australia, and from there to New Guinea, where MacArthur was headquartered. Rickenbacker's cover story was that Stimson had assigned him to inspect U.S. bases in the Pacific.

The flight to the southwest Pacific was operated by the U.S. Army Air Force's Air Transport Command. When it came to flying across vast stretches of water, the ATC had limited experience. In earlier years, it had flown supplies to Australia mostly over land, the main route beginning in Florida and going through Trinidad, Brazil, North Africa, the Middle East, India, Malaya, and Java. But Japan's conquest of Singapore and the Dutch East Indies early in 1942 blocked that path.

The pilot of Rickenbacker's flight was Captain William T. Cherry Jr., a 27-year-old Texan who had previously been a copilot for American Airlines. Rickenbacker later recounted in a confidential report that he was troubled that Cherry had not been a four-stripe aircraft commander with the airline, and he worried that the aviator lacked experience for the mission. In fact, Cherry had already made seven flights between Hawaii and Australia and had amassed 500 hours in B-17s and B-24s. But he sported a goatee, wore cowboy boots, had a drawl, and lacked the military bearing Rickenbacker was expecting. The two did not hit it off.

Rickenbacker was also unimpressed by copilot Lieutenant James C. Whittaker, a 41-year-old Californian. Whittaker was an avid flier, but he had virtually no experience in four-engine aircraft, and Rickenbacker thought he had no business in a B-17. Rickenbacker also thought Whittaker was too old to be assigned to an important transoceanic flight.

Lieutenant John J. De Angelis, a 23-year-old Pennsylvanian serving as navigator, seems to have been well respected by his crew mates, two of whom later praised his skills. On the other hand, they may have been trying to protect him because he, of all the crew members, was the one most accountable for the disaster ahead. Rickenbacker was sharply critical of De Angelis' lack of experience, which was not unusual for navigators at the time. Before the war, no airline except Pan American had used navigators, and after Pearl Harbor, most military personnel assigned to the role were given only minimal instruction.

COURTESY AUBURN UNIVERSITY ARCHIVES (2)

Racking up 26 kills in World War I earned "Ace of Aces" Rickenbacker (opposite, in a Nieuport 28 with a "Hat in the Ring" Squadron emblem) admiration on the homefront. But his behavior during the raft ordeal made some of his fellow castaways despise him (above, left to right: John Bartek, William Cherry, John De Angelis, and James Whittaker). In his journal (right) Rickenbacker detailed various tensions the men endured.

Radioman James W. Reynolds, 25, and flight engineer John F. Bartek, 23, rounded out the crew. Rickenbacker had qualms about Bartek's age and inexperience. Before the war, flight engineers of four-engine aircraft received 18 months of training; Bartek had had only four, and had never been assigned to a B-17.

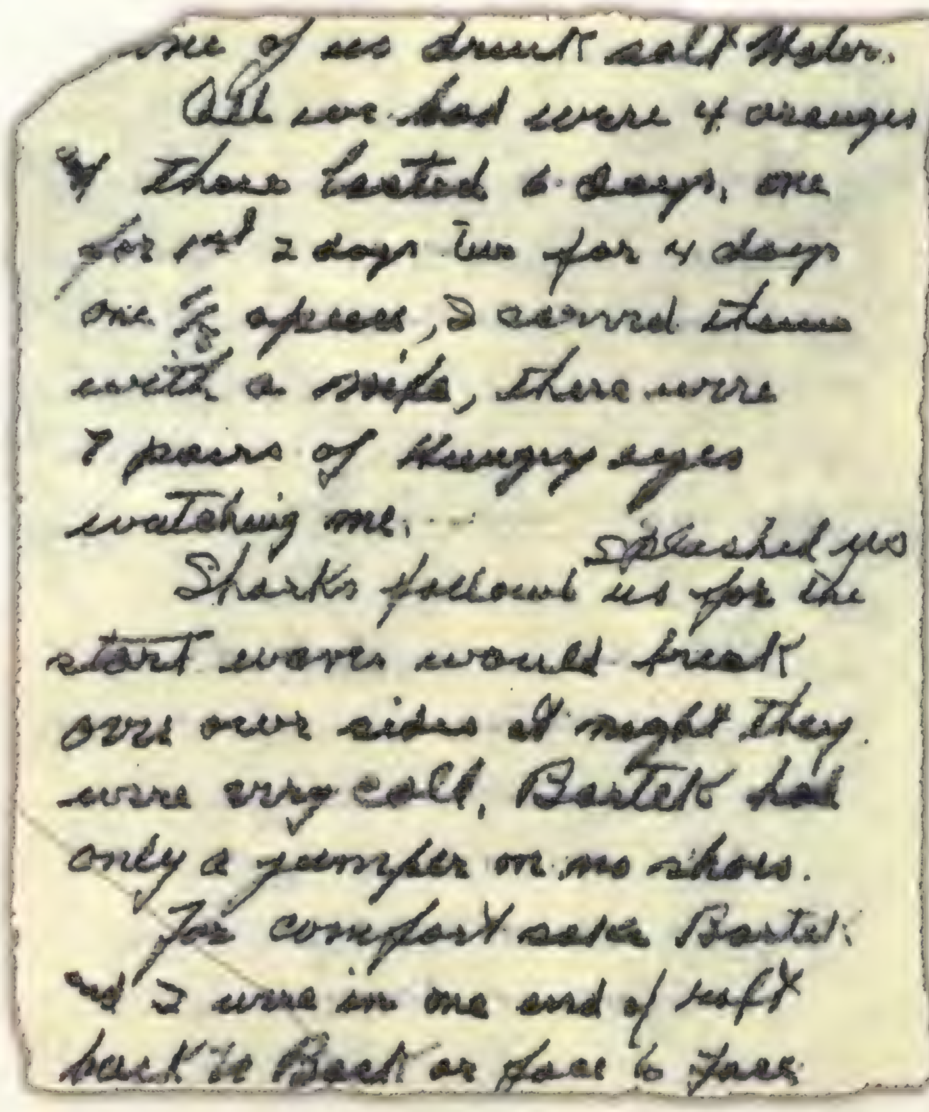
The eighth man on the airplane was Sergeant Alexander Kaczmarczyk, who had been a member of a U.S. Army Air Forces ground crew in Panama that had been transferred to Australia. En route to his new post, he had been detained in Hawaii for an emergency appendectomy, and he had also developed jaundice. Rickenbacker later complained that Kaczmarczyk was still too weak to be sent on a long transoceanic flight. He might have been even more critical had he known that one of the reasons Kaczmarczyk had been brought along was that he had worked on B-17s and thus might have been able to help Bartek.

Soon after Rickenbacker came home, an interviewer asked him how he rated most of his raft-mates as specimens of the American way of life. "Second level, I'd say," he snapped. Of course, this is a man who had once called President Roosevelt a murderer for ordering inexperienced and ill-equipped Army pilots to fly the mail in 1934.

Faulty maintenance was as responsible as anything for the debacle that would soon take place. As the aircraft started to take off from Hickam, a burst expander tube caused the starboard wheel to jam halfway down the runway, and Cherry barely avoided crashing into a building. As he got closer to the end of the runway, he had to ground-loop the airplane to keep it from plunging into Pearl Harbor.

A second B-17 was hastily rolled out. The crew didn't know it, but this aircraft also had problems. The magnetic compass may have been as much as 18 degrees out of adjustment for the planned flight path, and the radio direction finder, an outdated left-right pointer type, had a jammed directional loop. The loop was on the outside of the fuselage and had to be hand-cranked from the cockpit in order to intercept signals from a ground transmitter and thus get a DF bearing on a destination. According to a report he later submitted to the ATC, Cherry could not check the direction finder because no radio stations in Hawaii were broadcasting at that time of night.

The second airplane took off from Hickam, bound for the first refueling stop, Canton Island. Sleeping only fitfully, Rickenbacker thought the tailwind was much stronger than had been predicted. It was the first sign of yet another problem with the flight. Before the aborted takeoff in the first B-17,

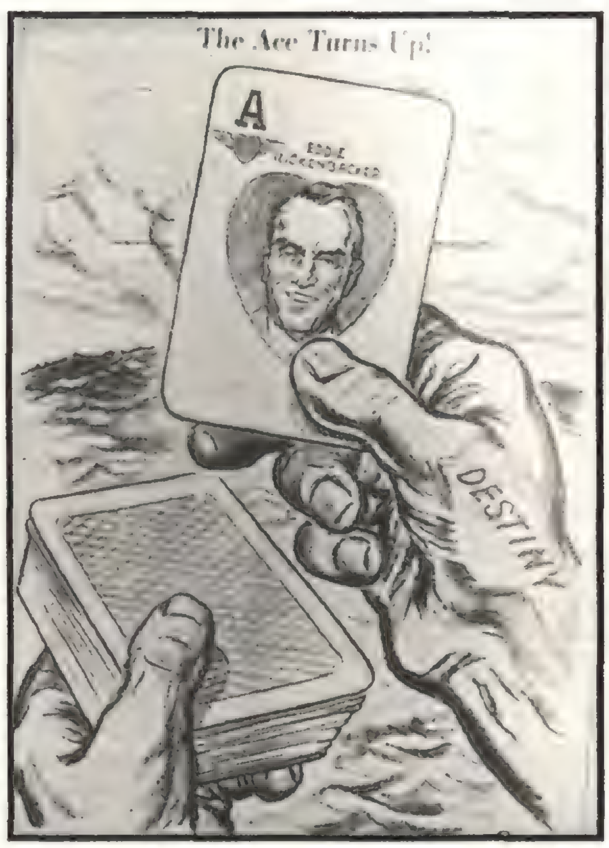


one of us drank salt water.
All we had were 4 oranges
& those lasted 6 days, one
for 1st 2 days two for 4 days
one ½ apiece, I carved them
with a knife, there were
7 pairs of hungry eyes
watching me. ...
splashed us
Sharks followed us for the
start waves would break
over our sides at night they
were very cold, Bartek had
only a jumper on no shoes.
For comfort sake Bartek
& I were in one end of raft
back to Back or face to face

De Angelis had not secured his octant, a delicately calibrated optical instrument used to determine the position of an aircraft from the position of certain stars relative to an artificial horizon. When the airplane ground-looped, the octant, which had been lying on a plotting table, "shot across…and banged against the side of the plane," De Angelis told Whittaker. The navigator brought the octant along to use on the second B-17.

As it turned out, the star fixes De Angelis took with the octant were worthless. Later, Rickenbacker would realize that without accurate fixes, De Angelis had miscalculated the airplane's tailwind and thus its groundspeed. He confirmed his theory when he learned that a C-87 leaving Hickam for Brisbane shortly before Cherry's departure had flown with a tailwind of 30 knots per hour—20 knots faster than Rickenbacker's crew believed.

Daylight broke at 6:30 a.m. After breakfast, Rickenbacker entered the cockpit, where Cherry told him that "everything seemed to be going along serenely." The ETA at Canton was 9:30 a.m., and Cherry soon began descending toward his target, which was less than eight miles long and four miles wide.



COURTESY AUBURN UNIVERSITY ARCHIVES

As he gradually lost altitude, Cherry turned up his radio and tried to get a DF bearing into the island, but the directional loop wouldn't budge "more than an inch or so," according to Whittaker—only a few degrees of the circle it was supposed to describe. Reynolds contacted Canton by Morse code (voice communication was not possible), only to discover that it could not give directional bearings to incoming airplanes; equipment for that purpose had arrived but was still in crates.

By 9:30 the B-17 was flying at 1,000 feet. Visibility was excellent, but Canton was nowhere in sight. Cherry looked puzzled; leaving Whittaker in charge of the cockpit, he went down into the nose compartment to talk to De Angelis. By this time, the navigator, who had been shooting the sun, had started to realize that something was wrong with the star fixes he had taken during the night. He complained to Cherry that he had not had time before the second takeoff to determine whether the octant was still in proper adjustment after its recent jarring, or to check and recalibrate any of the other navigational instruments.

Cherry returned to the cockpit looking upset. As the aircraft flew on without changing course, Rickenbacker felt a cold sensation creeping up his back, "as is my custom in emergencies," he recounted later in a chronicle of the episode. Finally, suspecting that Cherry had flown too far, he decided it was no time for cockpit etiquette and abruptly asked the pilot to check his bearings.

Because Canton could not provide a bearing, Reynolds radioed a naval station at Palmyra Island, about halfway between Hawaii and Canton. The station instructed Cherry to climb to 5,000 feet and circle for half an hour so it could calculate the B-17's position. But a B-24 was approaching Canton at the same time from another direction. Palmyra got it confused with the B-17 and gave Cherry the wrong heading.

As things became increasingly desperate, Rickenbacker recalled that in World War I, anti-aircraft guns had been used to give smoke signals, and he suggested that the crew radio Canton to fire shells into the air, set to explode at 7,000 feet. "I found out later that they had gotten our message and had fired their antiaircraft guns for half an hour," he wrote, "but we were so far away that we couldn't see the bursting shells. I also asked them to send up planes with the hope of seeing us or we seeing them, but the same conditions prevailed."

Shutting down the outboard engines to save fuel, Cherry climbed higher so he could see a larger area. At Rickenbacker's suggestion he began "boxing the compass," flying west, north, east, and south for an hour in each direction, but he didn't have enough fuel to finish the circuit. Rickenbacker later admitted that following the procedure merely increased the crew's ignorance of where they were.

By mid-afternoon the airplane had been in the air more than 15 hours and was almost out of fuel. Rickenbacker and Kaczmarczyk began jettisoning objects, not simply to lighten the airplane and conserve gas but also to reduce the impact of a crash-landing in the sea. Baggage, blankets, a suitcase, a briefcase, six bags of priority mail—all were fed to the waves. Rickenbacker and Kaczmarczyk then filled thermos bottles with water and coffee and put a box of emergency rations in the radio compartment, which had an escape hatch overhead.

Cherry descended toward the waves. Bartek prepared to pull levers that would deploy two life rafts from fuselage compartments that opened externally. They also readied a three-man raft. Everybody donned Mae West jackets. Looking out a window as the aircraft descended, Rickenbacker coolly called out estimates of their altitude.

The engines sputtered and died. A B-17 had never been ditched at sea without breaking apart, but Cherry did an expert job of guiding the airplane into a trough between swells, putting the tail down first to lessen the shock. With a crash it hit the water, followed quickly by another jolt when the fuselage collided with the waves.

Climbing through the airplane's two escape hatches, the men scrambled into the rafts, which were being buffeted by 12-foot waves. Lashing the rafts together with a line that Rickenbacker had wrapped around his waist before leaving the airplane, they drifted while sharks circled and bumped against the undersides of their vessels. The rafts were equipped with some survival gear: two knives, a pair of pliers, two bailing buckets, a first aid kit, patching equipment, and a Very pistol with 18 flares (12 of which turned out to be duds). But

there were no drift anchors, shark repellents, packets of dye to make the water noticeable from the air, mirrors to use for signalling, or radio transmitters—all standard equipment on later World War II rafts.

In the pandemonium of escaping the airplane, everyone had forgotten about the food and drink they had stashed in the airplane's radio compartment. When they realized they'd left the provisions behind, they decided not to go back, thinking—mistakenly, as it turned out—that the B-17 would sink rapidly and that the vortex would suck them down.

Now, on the rafts, the men had only four oranges that Cherry had found before exiting the airplane. Kaczmarczyk and Rickenbacker had chocolate bars in their pockets, but in his autobiography, Rickenbacker recalled that the saltwater had "turned them into green mush." And there was no drinking water.

Over the following days, the castaways tried to keep their morale up. Cherry and Rickenbacker organized devotional sessions at which Cherry addressed prayers to the "Old Master," his term for God. The men sang hymns like "Onward Christian Soldiers" and read aloud passages from a New Testament with Psalms that Bartek had with him.

They finished off the oranges, but the relief from hunger was only minimal. As survivors of other raft ordeals had found, a small amount of food is almost worse than none because it starts the gastric juices flowing without easing the hunger pangs. The men began to hallucinate about their favorite foods. Even worse was their unrelenting thirst and their craving for cigarettes.

Rains came, washing away the salt encrusted on the men's skin and providing water that they could squeeze from their clothes and drink.

One day a seagull landed on Rickenbacker's hat. Catching it by the legs, he wrung its neck, stripped off its feathers, and shared it with his ravenous mates. (After the men were rescued, clergymen throughout America delivered sermons about the incident, which they saw as eucharistic, and a sign that Rickenbacker was on a God-given mission.)

On the 13th day, weakened by his recent appendicitis and suffering from trench mouth, Alex Kaczmarczyk died. Against Rickenbacker's advice, he had tried to quench his thirst by drinking seawater. The men lowered his body into the water while De Angelis, a Catholic like Kaczmarczyk, chanted in Latin.

Rickenbacker had held Kaczmarczyk in his arms before the young man died; the captain's hard persona concealed a tender heart. But his abrasiveness did not disappear. He later explained that he hoped angering the men would stiffen their will to live, so he dressed them down vigorously. "I rode them; I tore them to pieces; I struck at every raw nerve in their bodies," he recounted proudly in his autobiography. There was no escape: The rafts were so small some of the men had to lay with their legs draped over one another's shoulders.

Meanwhile, the U.S. military had dispatched as many ships and airplanes as it could spare on a hunt for Rickenbacker and his comrades. Rickenbacker's disappearance was constantly in the news; thousands of articles and radio broadcasts paid tribute to him. Cartoonists vied to capture the public's sense of loss; a particularly poignant contribution by C. D. Batchelor showed a hero's wreath floating in the ocean, with the caption "So long, Eddie." (Once Rickenbacker was rescued, Batchelor sent him a copy of the same cartoon inscribed "Beg pardon, Eddie.")

Rickenbacker's admirers, however, refused to believe that he was dead. Joe Williams, a newspaperman and close friend, wrote a column that read in part: "We aren't going to give up on Rickenbacker until we are forced to read the obits. He's the closest image to Superman it's ever been our thrill to know."

Foremost among the faithful was Rickenbacker's wife, Adelaide. "Eddie will turn up," she said. "He's too old a hand

NATIONAL MUSEUM OF NAVAL AVIATION

Nicknamed "the Bug," the Kingfisher from which Rickenbacker and Cherry were spotted was based in Funafuti (later the capital of the British commonwealth nation Tuvalu). With an 800-mile range, Vought OS2U Kingfishers were well suited to scouting missions in the Pacific, though one cartoonist suggested that on this particular mission, success was attributable to another factor (opposite).

Several months after the rescue, Life *published a three-part series on the raft saga (opposite). Since photographs of the actual incident didn't exist, the magazine made do with illustrations and with the apparently staged photograph at right, in which a still-haggard Rickenbacker confers with Army Air Forces chief Hap Arnold.*

MYRON DAVIS, LIFE MAGAZINE © TIME INC.

to get lost in any airplane." Two weeks after her husband disappeared, she got a letter of condolence from Hap Arnold, which she feared meant that the search was being called off. According to her son William, she took a train to Washington, stormed into Arnold's office, and "practically tore the decorations off his jacket" demanding that the hunt continue. Arnold promised that it would.

The men on the rafts became increasingly despondent. One night, Adamson, tormented by pain, scarred with saltwater burns, and suffering from what was later diagnosed as diabetes, became delirious and tried to commit suicide by slipping over the side of the raft he shared with Rickenbacker and Bartek. After his two raft mates had pulled him back in, Rickenbacker gave him a tongue-lashing, and even though the miserable aide immediately apologized, Rickenbacker refused to shake his hand. He later claimed that while he felt terrible about his behavior, he believed that only a strong sense of shame would prevent Adamson from making another suicide attempt.

After almost three weeks the men spotted an airplane. They made frantic efforts to attract the pilot's attention but to no avail. Their hopelessness deepened.

Against Rickenbacker's objections, Cherry detached the smallest raft and paddled away, arguing that they would have a better chance of being spotted if they broke into smaller parties. Soon De Angelis and Whittaker also left, taking along Reynolds, who was by now unconscious. Together with Adamson and Bartek, both of whom were intermittently delirious, Rickenbacker floated on.

Cherry's instincts were sound. Not long after he cut himself loose he was spotted by a Vought OS2U Kingfisher floatplane. Cherry told the aircraft's two U.S. Navy crew members that the other rafts were nearby.

That day, Whittaker, De Angelis, and Reynolds washed up on the island of Nukufetau. They were found by natives, who summoned an English missionary. The cleric used a two-way radio to notify nearby American units that the three men were safe.

The following morning, November 12 as reckoned west of the international date line, five Kingfishers, four PT boats, and a support vessel began searching for the raft carrying Adamson, Bartek, and Rickenbacker. Late that afternoon, as two Kingfishers flew low over the waves, radioman Lester Boutte, the man who had earlier spotted Cherry, noticed something. Flying closer, he and the pilot, Lieutenant William Eadie, saw a yellow life raft with three emaciated men. Rickenbacker waved his battered gray hat at the airplane; Bartek waved his undershirt.

Short of fuel, both Kingfishers had to fly back to their base for gasoline. They soon returned, and as Eadie and Boutte settled down on the water and climbed out of the floatplane, Rickenbacker paddled his raft toward them, thinking, he recounted later, "how clean and handsome they were, how proud I was to have them as countrymen."

Eadie and Boutte gave the three men soup and water and prepared to take them to Funafuti, 40 miles away. Because Adamson was in particularly bad shape, Eadie and Boutte put him in Boutte's radio cockpit; then they lashed Bartek in a seated position to the leading edge of the right wing and tied Rickenbacker to the left, preparing to taxi to Funafuti. "God bless the Navy," Rickenbacker muttered as they went about their work. As Eadie set out, a PT boat arrived, having been summoned by the second Kingfisher. Eadie and Boutte untied Rickenbacker and Bartek and put them on the vessel, then took Adamson on to Funafuti. (Their trip set a world record for taxiing in a seaplane.)

Exhausted, Bartek lay in the PT boat thinking *I'm not going to move for another year.* Rickenbacker, however, was too excited to rest and asked for something to drink. The crew warned him not to drink too much too fast, but he ignored them and filled up on water, broth, pineapple juice—anything he could lay his hands on. Soon Bartek revived and he too drank one container of water after another.

After they got to Funafuti they were carried to a makeshift hospital. Later the Kingfisher arrived with Adamson, who was also brought to the crude building. Rickenbacker was still tortured with "an unquenchable thirst." When he awoke the next morning and looked in a mirror, he was dismayed by his loss of weight—he had gone from 180 pounds to 126—and the dirty beard and drooping mustache he had grown. Knowing that he was likely to be photographed, he demanded a haircut and shave.

At 9:00 a.m. on November 13, Adelaide Rickenbacker's phone rang. It was Hap Arnold, telling her that Eddie was safe.

Preparations got under way to give Rickenbacker a hero's welcome in the States. First, however, he was determined to complete his mission. After recuperating for about two weeks at a hospital in American Samoa, he flew to Brisbane, then on to New Guinea.

A report Rickenbacker dictated immediately after he got home recounted that he had been driven to MacArthur's Port Moresby headquarters, which he described as a "frame shack with an outhouse." Actually, it was Government House, the largest building in New Guinea. Its roof was battered, but it had four bedrooms, a large book-lined living room, and, according to Geoffrey Perret, the only flush toilet on the entire island, which had been installed for MacArthur's exclusive use.

Rickenbacker was nervous about delivering Stimson's harsh message. But MacArthur, aware that Rickenbacker was merely a messenger, listened without reacting. Beyond that, everything went well and the weekend marked the start of a lasting friendship between the two. (MacArthur had become an avid believer in air power, having been converted by the successes of his chief air officer, General George C. Kenney.)

At 9:00 a.m. on December 19, Rickenbacker arrived in Washington, landing at Bolling Field. It was swarming with dignitaries, but Rickenbacker had eyes for only three people: Adelaide and his two teenage sons, David and Billy. As Rickenbacker swept them up in his arms, the crowd yelled, flashbulbs popped, fighter aircraft zoomed and dived, and a band played.

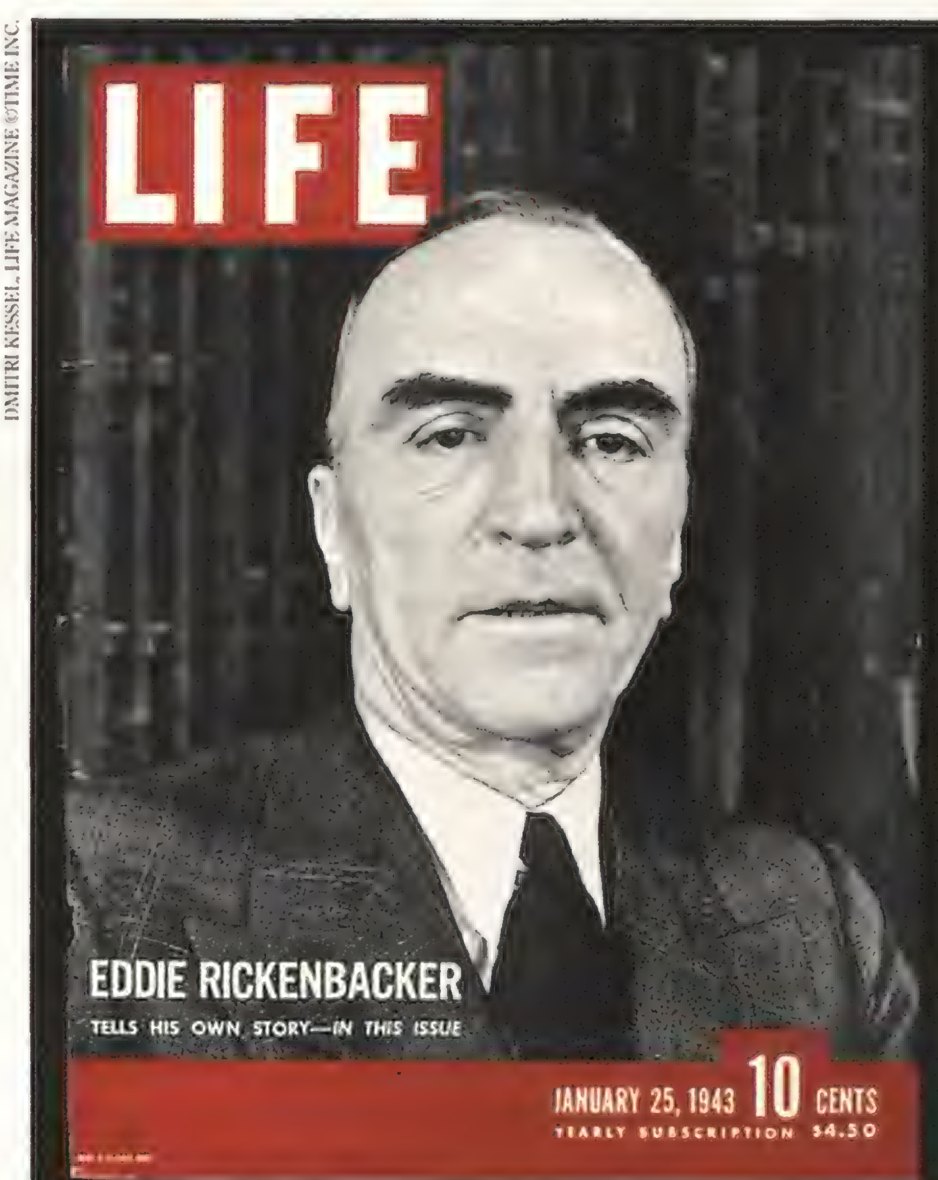
Exultation swept the country. When Rickenbacker's book about the ordeal, *Seven Came Through*, was published, it became a best seller; an article he wrote for *American* magazine, "When a Man Faces Death," created such a sensation that more than a million copies were printed and given to servicemen leaving for far-off theaters of war. People wanted Rickenbacker to run for president (he declined).

But for the Ace of Aces, the nightmare of the raft never really ended. A nagging thirst continued to torment him, compounding a drinking problem he had had before the mission and would have until his death.

The raft experience haunted other survivors as well. According to some members of the Rickenbacker family, one of the downed crew members, still feeling the sting of Rickenbacker's abusive ranting on the raft, wrote him threatening letters and stalked him from one speaking engagement to another, glaring at him from the audience. (The crew member would not discuss any aspect of the episode or its aftermath.)

The ordeal in the Pacific, however, did have an uplifting side. As I went through all of the letters Rickenbacker had received upon his return, I realized that the rescue had helped keep the nation's morale high at a critical period of the war. One admirer from New Jersey wrote: "Never before in all my life have I ever wanted so much to shake the hand of another person—and when this mess has all been straightened out—and we will straighten it out with the help of men like you—I hope that the privilege will be mine." I also found a letter that aviation pioneer Roscoe Turner wrote to Adelaide Rickenbacker praising her for serving as a leader for "the wives and sweethearts that are waiting for their loved ones to return" from the war.

The year had begun with a series of demoralizing defeats, but beginning in April with Jimmy Doolittle's raid on Tokyo, continuing through the stunning naval victory at Midway in June, and reaching a climax in November with the invasion of North Africa, the momentum of America's victories made it seem more and more likely that the Axis powers would be defeated. By the time Rickenbacker and his fellow castaways were found, good news was being reported from several theaters: from the jungles of Guadalcanal, where Japanese resistance was weakening; from New Guinea, where MacArthur's forces were breaking through enemy lines at places like Buna; and from North Africa, where British forces were pressing against Rommel in Libya and the Allies had control of Algeria. Reinforcing the nation's growing confidence in its own power, the rescue of Eddie Rickenbacker came at just the right time.



DMITRI KESSEL, LIFE MAGAZINE ©TIME INC.

Lifeboat

NASA's first homebuilt spaceplane

by Preston Lerner

The unpiloted X-38, here carried by NASA's B-52, is the precursor of a space station rescue craft.

A venerable Boeing B-52B in NASA markings and bearing tail number 008 trundles down a taxiway at California's Edwards Air Force Base on a crisp November morning. Beneath its starboard wing, where the dart-like X-15 was once carried, a dumpier egg-shaped craft dangles from a pylon. Black along the bottom and white on top, the thing looks like a spat-clad shoe with stubby wings protruding from either side of the ankle—which is only fitting, really, because this winged foot is the X-38, and it will take the next step into space.

The X-38 is the latest in a long and distinguished line of X-planes, including the X-24A lifting body, which inspired it. The X-38 is also the unmanned prototype for NASA's first manned spacecraft since the shuttle. An operational version known as the Crew Return Vehicle (CRV) is scheduled to dock at the international space station in 2003 as an emergency lifeboat. Meanwhile, the European Space Agency (ESA) is hoping to develop a more elaborate shuttle-like model known as the Crew Transfer Vehicle.

NASA has spent only $90 million to build four test vehicles—three for atmospheric tests and one poised to fly into space on the shuttle in 2000—which amounts to little more than petty cash in the agency's budget. But because the X-38 is being touted as an example

NASA/TONY LANDIS

of the agency's self-proclaimed ability to get things done faster, better, and cheaper, the X-38 is burdened with a controversy that may weigh more heavily on it than the seven astronauts its successor is supposed to ferry back from the space station. NASA has also decided to assemble this spacecraft in its own shops, and critics in government and among space advocacy groups complain that NASA shouldn't be building a spacecraft; better, they say, that the work be done by the private sector. And if the X-38 fails, the critics will question not just the wisdom of this one program but also the agency's management of the space station program generally.

The project is already months behind schedule. ESA was forced to scale back its participation after France dropped out of the program. On the technical front, the biggest headache has been the parafoil—a colossal parachute-like wing with a span greater than a Boeing 747's—that helps to slow the spacecraft for landing. Although parafoils for people are commonplace, this oversized version has experienced several catastrophic test failures. So this morning, instead of dropping from the wing of the B-52 and landing on the dry lakebed, the X-38 will remain attached to the pylon for a fourth captive-carry flight.

A lesser man than program manager John Muratore might be discouraged. But Muratore, who was chosen for this job by NASA Administrator Dan Goldin, is a relentless optimist. "I'm not concerned about slippage," he insists. "I'm concerned about maintaining the character of the program—moving fast, taking risks, making mistakes, learning lessons, and rapidly incorporating them. The biggest value of the X-38 is that we're designing it ourselves and we're building it ourselves. I'm not saying that we ought to do every project hands-on. But we need a core of people with that kind of experience."

Muratore is sitting in the hot seat—the mission controller's chair—smack-dab in the middle of a compact, bustling control room at the Dryden Flight Research Center, the NASA facility at Edwards. Of the two dozen or so engineers crammed around him, most of them based at Dryden, the older ones wear button-down shirts and slacks of uncertain vintage. The younger ones, earnest and fresh-faced, look like they've stepped out of an Eddie Bauer catalog. Muratore, who is 41 and sports an olive-green flight jacket with an X-38 patch, blue jeans, and spotless white Reeboks, splits the difference between the two camps in both age and attire.

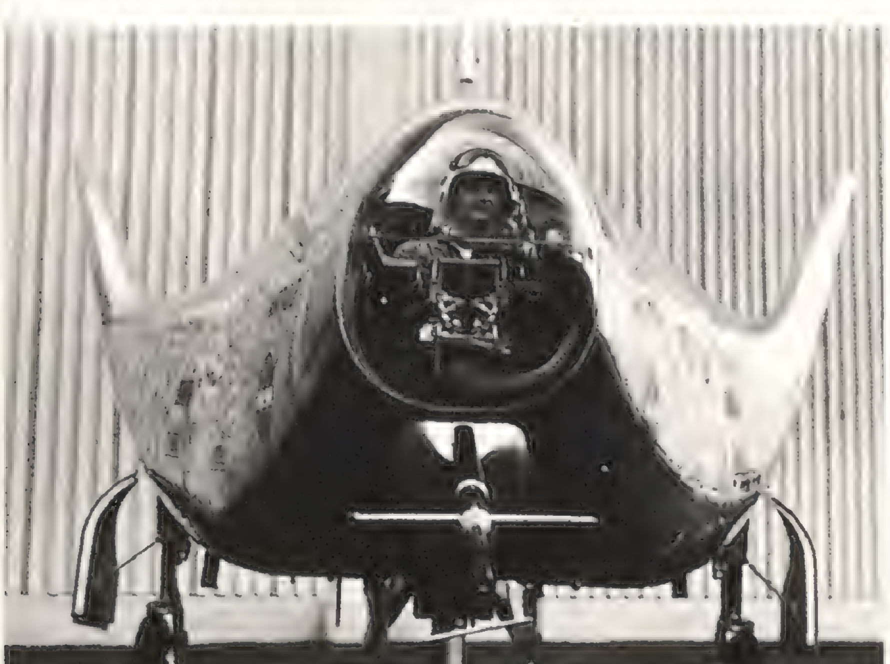
A brisk, sometimes brusque New Yorker with a Dale Earnhardt mustache and a Rudy Giuliani attitude, Muratore isn't happy unless he's doing three things at once. At the moment, he's watching video monitors depicting the X-38 and computer screens displaying the status of various onboard systems. Through a headset, he's keeping tabs on a load cell—a sensor that measures the aerodynamic forces on the pylon—that's not working properly. Oh, and he's also talking on the phone to a NASA budget wonk who is trying to cut a few million dollars from the program.

"Hang on," Muratore snaps. He flicks a switch on his console. "I concur," he says into the headset, agreeing with chief engineer Chris Nagy that the load cell squawk isn't serious enough to force the team to scrub the mission. Muratore returns to the phone and testily tells the bean counter, "Look, I can't give you an X-38 budget without a space test in it." After he hangs up, there's a ragged cheer. "If he calls back," Nagy says, "I'll tell him you're busy."

The B-52 taxis onto Runway 22. "Okay," Muratore says into the headset, "let's go around the room. Go or no-go for takeoff." One by one the reports come in: It's a go. Muratore kicks back in his chair, pauses thoughtfully, then grins. "Okay," he says, "everybody's seatbacks forward and tray tables in an upright and locked position."

A lot of people have ambitious ideas for the X-38. NASA wants the CRV to serve as a taxi, hauling people and products between the space station and other locations in low Earth orbit. (The space station budget earmarks $500 million to build four CRVs.) ESA sees it as a low-cost vehicle for commuting between Earth and space. First and fore-

NASA test pilot Milt Thompson ogled the outside world from the front office of the HL-10, one of a series of lifting bodies that flew in the 1960s and '70s (left). No pilot or cockpit, but the X-38 still looks like a member of the family (below). Fabric tufts on the fin will reveal areas of turbulence (opposite).



NASA

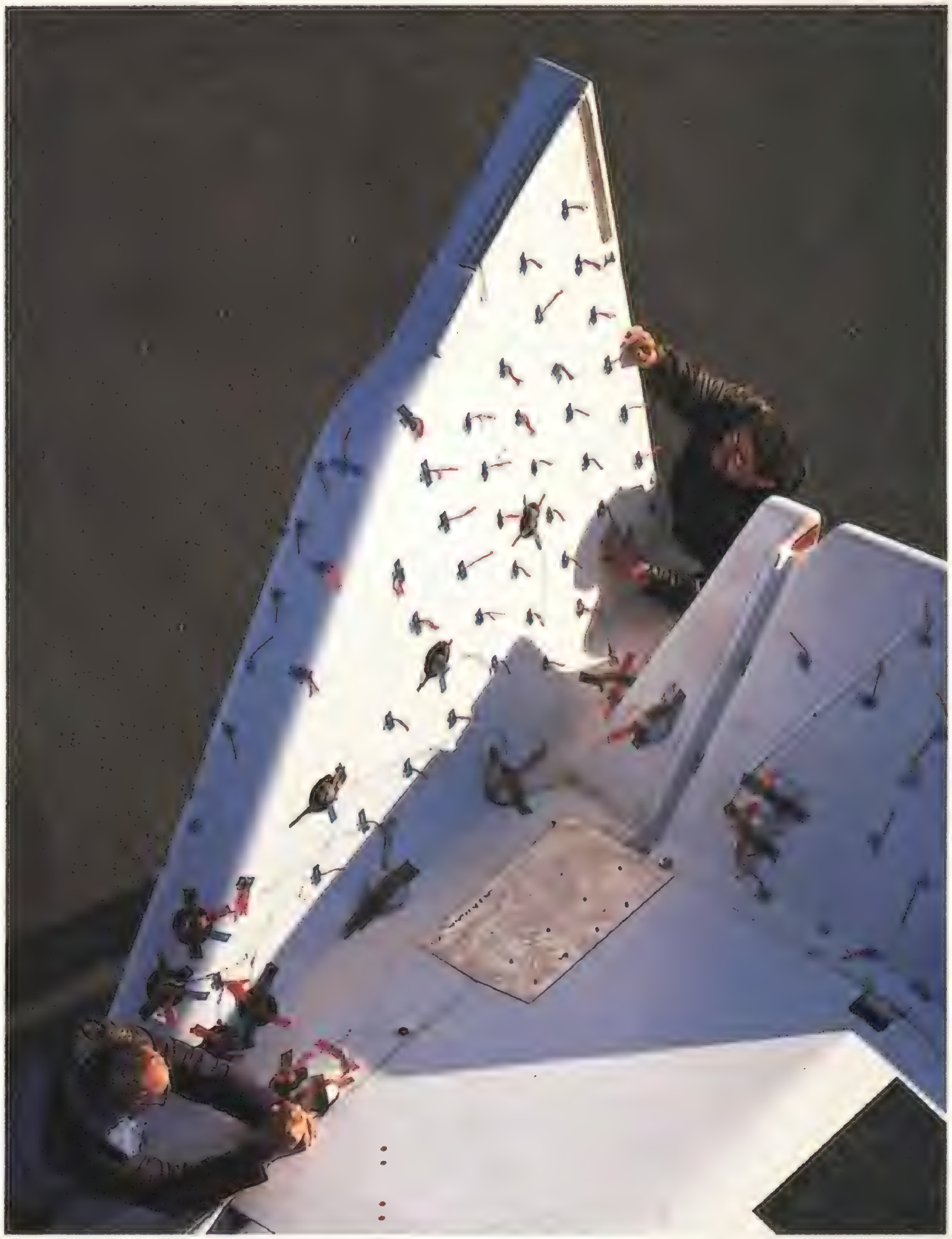
CHAD SLATTERY

most, though, the X-38 was envisioned as the answer to a what-if question: What if something goes wrong with the space station and it has to be evacuated—*now*?

The Russian Soyuz spacecraft will serve as a stopgap while the station is being built, but it's too small to haul everybody home from a fully staffed station. NASA needed an alternative, and Muratore was the one to provide it. When he directed the overhaul of the mission control center at the Johnson Space Center in Houston, he established himself as a rising star. (A flattering *Rolling Stone* profile likened him, improbably, to Che Guevara.) His selection of commercial computer hardware and software to revamp JSC also fit Goldin's faster-better-cheaper paradigm. Who better to create a man-rated spacecraft that, in a departure from NASA tradition, would be built around off-the-shelf technology?

Late in 1994, Muratore started brainstorming with a small group of young engineers who'd helped him with the overhaul at JSC. What they had in mind was a spacecraft that could be delivered to orbit in the cargo bay of the shuttle or on top of a rocket. It would then dock indefinitely at the space station, ready to return to Earth at a moment's notice. And it would do all this for a fraction of the cost NASA was accustomed to spending on manned space vehicles.

CHAD SLATTERY



The obvious solution was an Apollo-style capsule, which was aerodynamically straightforward and could be based on decades of flight data. But a capsule meant troubling trade-offs. If it left at the worst possible time in the station's orbit, the return trip could take as long as 24 hours, which would necessitate complicated and expensive power and life support systems. And only twice in those 24 hours would the astronauts' orbit cross the point where they could initiate reentry. A capsule has the flying qualities of a two-by-four, so it reenters along a fixed path that dictates its starting point.

Enter the lifting body—a fuselage shaped so that it generates lift. A lifting body vehicle would get astronauts home a lot faster than a capsule while also giving them more chances to land. (The worst-case scenario calls for three landing opportunities during a nine-hour trip.) The downside was the thorny aerodynamic issues associated with lifting bodies (see "The Legacy of the Lifting Body," Apr./May 1991). But here, Muratore and company were in luck: During the 1960s and '70s, NASA and the Air Force had extensively flight-tested an assortment of odd-looking lifting-body aircraft, starting with the plywood and steel M2-F1 glider towed by a souped-up Pontiac. A later version, the M2-F2 (rebuilt as the -F3), was fitted with a Reaction Motors 6000C4/XLR-11 rocket, the engine that had powered the Bell X-1 through Mach 1. The similarly powered HL-10 had maxed out at 1,228 mph and 90,303 feet (see "Bringing Up Betsy," Dec. 1988/Jan. 1989).

But the vehicle that came closest to what Muratore wanted was Martin Marietta's homely X-24A, a scaled-up version of the unmanned X-23A. The Air Force flew three X-24s during its own lifting body program, and the CRV concept team could tap into flight test data from the combined NASA and Air Force programs.

The dimensions of the X-24 provided a basis for a new spacecraft with the required internal volume. Although the X-38 is somewhat larger—it measures 29.6 feet long and 16.7 feet wide—it will still fit atop such boosters as the Titan IV, the Delta IV, the Russian Proton D-1,

CHAD SLATTERY (2)

and the Japanese H-2. It can hold seven reclining seats in CRV form or three ejection seats as the CTV. The X-24A shape went through some serious contortions to accommodate these extra passengers, but viewed in planform the X-38 is a dead ringer for the X-24A.

Flying the same reentry profile as the shuttle, the spacecraft will have 700 miles of crossrange (left or right deviation from a ballistic course) capability. "Unfortunately," Muratore says, "it weighs a lot, and the wing loadings are very high. If you were to use a runway, you would need to land it at 250 knots [287 mph]. Now, that's doable with a highly trained crew member on top of his game, and maybe it's possible with an automatic landing system and a deconditioned crew, but it would certainly be very difficult to do in any kind of emergency. So we said to ourselves, 'How can we slow this down enough so that we can land it in anyone's backyard?' "

Made for NASA by NASA: The X-38 space test vehicle, the final prototype in the series, takes shape in the chapel-like setting of the assembly jigs at Johnson Space Center (top). X-38 program manager John Muratore tries a cabin mockup on for size (above). In a 1968 wind tunnel test, the Air Force's X-24 (opposite) gave up its secrets.

Once again, the X-38 team turned to technology pioneered during the 1960s: A parafoil is a ram-air parachute with separate upper and lower rectangular surfaces connected so that the leading edge is open and the trailing edge is closed. "When the parafoil is inflated…it takes on the shape of an airplane wing," says Dean Jorgenson, engineering program manager at Pioneer Aerospace Corporation, designers of the parafoil. "What you have now is a flexible airfoil that can be maneuvered the same way you maneuver an airplane."

During two years and 20 drop tests at Yuma, Arizona, the X-38 team has mastered the ability to fly the parafoil using a modified set of remote-controlled truck winches to tug on the control lines and steer it. Inflating it in the first place has been the problem. Flight test director Koki Machin blames "the funky dynamics" caused by inflating a ram-air canopy over loads of up to 18,000 pounds.

In smaller personal parafoils of 200 square feet, a so-called slider reef slips down the suspension lines as the 'chute deploys, progressively opening the canopy in a controlled manner. But because the X-38 parafoil is so huge—50 by 110 feet, or 5,500 square feet of fabric weighing 750 pounds—a slider reef is too crude for the task. Instead, the parafoil has to be folded like an accordion so that its 31 cells deploy like a giant daisy chain. It's no wonder it takes three people eight days to pack the thing. Or that it sometimes doesn't work the way it's supposed to. As deputy program manager John Hooper puts it: "Over the years, a lot of people have stubbed their toes on large parafoils." As they neared the end of 1997, the X-38 team had what

seemed to be a perfectly good aircraft—and no good way to land it.

The biggest obstacle Muratore faced when he revamped mission control was, strangely, NASA itself. The agency had matured—some would say ossified—since its epic triumphs of the 1960s, and after the calamities of the 1980s, it seemed more concerned with avoiding failure than with courting success. It was no coincidence that engineers had been supplanted by bureaucrats in the agency's hierarchy.

Muratore and his gang saw themselves as guerrillas. They dubbed themselves the Node Pirates and flew a Jolly Roger. They even adopted the pirate's code: "You live by the sword, you die by the sword," says Carol Evans, who worked with Muratore on the mission control project and who is now the X-38 vehicle delivery manager. "We do whatever we have to do to get the job done.

X-38

The early lifting body research craft carried only a single test pilot. Though similar in size, the unmanned X-38 and its follow-on, the CRV, carry seven astronauts.

But we don't have a safety net. If we fail to deliver, then we don't deserve a project."

Muratore's reputation as a renegade was a major reason he was hand-picked to ramrod the X-38. But even though he brought much of his old crew to the program, he's toned down the pirate rhetoric. Goldin's faster-better-cheaper mantra is now the agency's fight song. And rather than continue to antagonize the old guard, Muratore prefers to dwell on how the X-38 fits into NASA's culture: "This is a return to our roots, when there was an emphasis on flight testing and hands-on construction," he says.

NASA

Although many of the X-38's systems were built by vendors, Vehicle 132, the second of three planned atmospheric testbeds, is being assembled at Johnson in Building 220. A surprisingly small team of surprisingly young, surprisingly casual men and women are crawling over, under, and inside the largely completed vehicle. Overseeing its assembly is Phil Dempsey, a 32-year-old engineer who, like most of the hundred or so people working on the project, volunteered for the program because it sounded exciting. "I'm still at the stage when I like to get my hands dirty," he says. "I call it playing. Here, I get to do some of the installation myself."

Vehicle 132 won't be going into space, so the body was built out of ordinary fiberglass by Burt Rutan at Scaled Composites in Mojave, California. The space-rated vehicle 201 will feature carbon-fiber composite pieces fabricated in NASA shops and bonded to an aluminum frame formed on NASA's computerized milling machines. In fact, some parts forming a portion of it have been positioned (by a laser) on a flat plate at the other end of Building 220.

As David Young, the engineer in charge of manufacturing, runs his hands over exquisite pieces milled out of huge billets of aluminum, he's struck less by the workmanship than by what it represents: NASA has built satellites and other spacecraft before, but this is more like a shuttle. "The project is a departure from the way we usually do business," he says. "NASA usually writes requirements and awards contracts and oversees what contractors are doing. So in the past I had no power to get anything done other than going to contractors. With this program, I'm in a position to do something on my own, and I'm responsible if something goes wrong."

Sounds like a good thing, right? Actually, this hands-on approach has touched off bitter attacks on the X-38 by those who want the private sector to be the force that commercializes space. They say NASA should have written the requirements for the program and put them out for bids. "This is something that private industry could have handled," says Rich Kolker, a founding member of the Clear Lake Group, which is a self-described "space policy re-

search" organization that conducts weekly conferences on the Internet. "It's not an R&D program. It doesn't involve any new technology. It exists simply because Dan Goldin wanted to get the people at NASA technical again."

Still, even the X-38's fiercest detractors acknowledge that the program may improve the breed. But at what price? And toward what end? "NASA keeps saying that this program is going to make them a better customer," complains Rick Tumlinson, president of the Space Frontier Foundation, a group whose purpose is to "unleash the power of free enterprise" in the space arena. "Customer for what? We want them to be customers for services. We don't want them to be customers for hardware. We want them to be hiring a trucking company, not building a truck."

Tumlinson says the X-38 falls awfully far afield from cutting edge research. Yes, the operational CRV will be built by vendors, but the X-38 is effectively its prototype. Under the circumstances, critics argue, it's disingenuous for NASA to represent the project as an X program, which carries immense prestige and exudes loads of sex appeal, rather than giving it the more prosaic Y designation awarded to programs to develop operational aircraft. "This is a Y program in X program's clothing," sniped a Congressional staffer who spoke on condition of anonymity. "If you're talking about testing lifting body technology, we've already had the X-24. If all they wanted to do was test parafoil technology, they don't need a spacecraft. This is clearly the prototype for an operational vehicle. It's no coincidence that NASA has taken to referring to the CRV as the X-38B."

Meanwhile, there's more trouble brewing on the other side of the Atlantic. For the past year, NASA has been collaborating with ESA, a consortium of 14 European nations, which had shelved its own capsule-based concept in favor of the X-38. To date, ESA has spent $34 million on the program, and it has budgeted another $36 million for 1998. But ESA's enthusiasm was undermined when France, which had been the project's biggest European booster, cut all funding for the X-38.

Ironically, the vehicle had already been redesigned to meet ESA's objectives for the CTV. To begin with, the Europeans planned to launch their spacecraft on top of an Ariane 5 booster with three astronauts inside. This meant that the cockpit had to be enlarged to accommodate upright seats that could be ejected if the launch was aborted. Then the fuselage had to be widened to attach properly to the launcher. Finally, ESA's own extensive aerodynamic analysis, some drawing from work on the ill-starred Hermes, a French lifting body spacecraft project that was canceled in 1992, prompted substantial changes to the leeward portion of the craft.

Although the first two X-38s feature NASA's original shape, the third one, vehicle 201, reflects the partnership with ESA. In May 2000, it's scheduled to fly into space in the shuttle. With its wings folded, the X-38 will fit in the cargo bay. But plans to build vehicle 202 and launch it on an Ariane 5 in 2002 have been scrapped in the wake of France's decision to quit the program. "We are now concentrating our efforts on vehicle 201," says Eckart Graf, ESA's CTV program manager. "The CTV is more the distant future."

Despite what he calls France's "deplorable" decision, Graf remains upbeat. He's proud of the impact his 22-man X-38/CRV/CTV team has had, and he's amazed by how quickly ideas have

NASA/CARLA THOMAS

Last March, a test of the parafoil had its hairy moments (above), but the research vehicle landed intact (opposite). Next come more atmospheric tests, and then the big one: a return to Earth from space.

been turned into reality. Plus, he's got some personal history with lifting bodies. "In 1970, before I even joined ESA, I watched the HL-10 take off under the wing of the same bomber—008—that's carrying the X-38," he says. "So for me, this is closing a circle."

Here's the way everything is supposed to work: The space station is spinning out of control. Job one is getting the hell out of Dodge. The crew slides into the CRV through a hatch in the top of the spacecraft. The hatch is shut and pressure integrity verified. Thirty seconds gone. Inside, the accommodations are spartan. All seven passengers lie on their backs, one in the nose, two behind him, and four just aft of the rear bulkhead. Although this is a shirt-sleeve environment, they pull on G-suits and strap themselves in. Figure another two or three minutes.

Normally, disconnecting from the station takes 10 minutes, but now time is precious. The commander detonates an explosive to sever the docking latches and fires thrusters on the nose and tail to separate from the station. Various landing sites are displayed on monitors along with relevant information about the ground track and the time until the de-orbit burn. Once the commander selects a landing site, the computer, using Global Positioning System satellite navigation, does the rest.

The CRV turns tail-first just before it enters Earth's atmosphere. After firing its engines, the lifeboat rotates back around and jettisons the de-orbit module. A series of banked S-turns bleeds off speed, and the nose is pitched well up to control heating.

Just before the CRV goes transonic, it pitches down. At Mach 0.8 and 23,000 feet, the drogue chute deploys from the tail and the astronauts feel their bodies press forward. Two explosive bolts are fired, severing two of four attachment points so that now the drogue repositions itself at the top of the CRV and the spacecraft floats down in a horizontal attitude. At 15,000 feet, the drogue is cut loose and the parafoil deploys in five stages, a process that takes a total of 35 seconds. The astronauts feel themselves swinging back and forth as they watch their descent on video monitors.

The pilot can take control or let the computer do the work. Landing skids drop down automatically. The CRV touches down gently—a major consideration with occupants who are injured or deconditioned—at 40 mph and 15 to 20 vertical feet per second. (Apollo capsules landed at 28 vertical feet per second.) The whole flight takes 90 minutes. In theory. If the parafoil works. If.

Now it's March 12, and at 23,000 feet above a lakebed flooded by recent El Niño rains, NASA's B-52 workhorse canters through a cloudless sky with the X-38 underneath its wing. But this isn't a captive-carry flight. This morning, the X-38 will be dropped and left to fend for itself. "All stations," chief engineer Chris Nagy intones into his headset, "15 minutes to hot pass. Fifteen minutes to hot pass. This one is real."

Time inches forward. At 8:30 a.m. Nagy counts down and the X-38 drops like a stone. "The next four seconds are critical," whispers Jeff Daughterty, who was the launch program officer in the B-52 on several captive-carry flights, as he watches the video. This vehicle has no working control surfaces, so a radical pitch up or roll could be disastrous. Unexpectedly, the X-38 rolls nearly 60 degrees to the right. Daughterty tenses, but then the vehicle recovers. After four seconds of free flight the hatch covering the parachutes blows off. Soon, a drogue chute pops out.

Now comes the biggest hurdle—deploying the parafoil. Fifty-five seconds after the drop, a giant red, white, and blue canopy billows out of the X-38. Suddenly, sickeningly, the aircraft whips around two and a half times as it tries to keep its nose into the wind. The lines twist before the parafoil can unfurl fully. Then the fabric rips.

A wave of dismay ripples through the control room. But the tear isn't major, and the X-38 soon settles into a docile flight path. With the winches controlling the parafoil being operated via a laptop computer on the ground, the X-38 sinks toward the target zone. Seven minutes and 19 seconds after separating from the B-52, at the end of a flight of 1.6 nautical miles, the aircraft brushes past a creosote bush on the way to its inaugural landing. "That is so cool!" Daughterty whoops. "So many hours of work! So many hours..."

And so many hours to go before the X-38 will be ready for its big test: a return from space. The vehicle itself was stable, recovering from a roll to the right induced by airflow from the B-52. "Obviously, the vehicle is airworthy and it flies fine," Muratore exhulted.

After the test, engineers were studying how the action of the drogue chute may have affected the parafoil's deployment and also looking at reinforcing the fabric to prevent tearing. The first new spacecraft in 20 years to carry humans home from orbit is running a little late, but it's on its way.

NASA/TONY LANDIS

U.S. NAVY

LOCKHEED MARTIN

>SIGHTINGS<

An aircraft carrier is many things to many people—a city at sea, a colossal engineering achievement, the Pentagon's trump card in defense maneuvering—but from all angles, it is also a magnificent sculpture. At left, bathed in saltwater mist from the flight deck decontamination system, which is used to wash away nuclear, biological, or chemical residue, the *Abraham Lincoln* has a distinctively non-military appearance—one gets the feeling that at any moment Esther Williams, an orchestra, and a raft of showgirls might rise from the deck.

A carrier can also serve as the world's biggest barge. When the one above shipped fighters to Great Britain in the 1940s, the flight deck resembled a Busby Berkeley musical with its precise geometrical patterns.

Charles Kerlee caught a vertigo-inducing moment over the wooden deck of the *Hornet*

in 1945 in the China Sea from a Curtiss SB2C Helldiver. The photograph at right would be at home in any art gallery, as would the others that appear in *Steichen at War*, a collection by Edward Steichen and other noted photographers.

David Peters captured the angularity of the flight deck, the whiskery antennas, and the frothy wake of the *Kitty Hawk* in the Pacific (below) from an SH-60 anti-submarine helicopter at 1,500 feet. "The pilot had just got the word from the ship to wrap it up," he writes. "They were waiting for us to finish so they could set up the barbecues on the flight deck for 'steel beach,' the crew's only day off in weeks. We were coming directly over the ship for the last time and I was finally getting the angle I was looking for. The flattop was really flat in the gray overcast. I was hanging out the open door of the helicopter, the rotor wash trying to pull my shoes off, dangling by a single web belt directly over this airfield floating in a deep blue sea. And then it was over. I kind of felt like Ed White during his spacewalk, being ordered back into the spacecraft and not really wanting to go."

Tomorrow's carriers will be the oddest sculptures of all. Sleek and stealthy—well, as sleek and stealthy as a 100,000-ton machine can be—the ships will be unmarred by the traditional island, the multi-story command post on the side of the flight deck. Replacing the steam catapult will be a liquid-fuel system that drives the catapult by gas pressure. Then, the hurling of an aircraft off the flight deck will truly be a launch in every sense of the word.

DAVID PETERS

CHARLES KERLEE

Model Box Masterpieces

Flying Colors: The Works of Shigeo Koike. *Text by Katsuhiko Tokunaga. Sony Magazines Inc., 1997. $85.00 (available through Marco Polo Import, Inc., 626-333-2328), 126 pp. (hardcover with slipcase).*

Japanese aviation artist Shigeo Koike paints for people who are in love with flying machines. Guided by a painter's eye, he throws light inside an engine cowling, behind an open speedbrake, or into a wheel well and lets you enjoy the details. Viewers of photographs easily forget the limitations of the camera and are too quick to believe that a photograph is unquestioned reality. This artist gives back what shadows have so often stolen.

Koike does not stop there. The passengers and crew inside his cockpits and cabins are more than just obligatory silhouettes. They are active, believable people filled with purpose. His clouds and skies are equally well done and establish mood. The viewer feels he is in the picture, part of the action. Usually only a wingman ever gets such a complete view.

Each image in this collection of 58 paintings includes a brief paragraph written in Japanese, but the name of each aircraft is given in English subtitles. The book is divided into two sections. The first, "Legend and Legacy," is a collection of 44 paintings that feature internationally significant aircraft from the 1920s through the 1940s. "The Great Airplanes" section includes 14 paintings that were initially created as art for model airplane kit boxes produced by Hasegawa Seisakusho Co. These include Japanese, German, Italian, U.S. and English World War II fighters, and the section also includes contemporary jets, including a Grumman F-14 Tomcat and a Lockheed Martin F-16 Fighting Falcon, as well as a pair of helicopters, including the AH-64 Apache.

In addition to paintings, the book contains pencil drawings of three of the featured aircraft, which display Koike's meticulous research and planning, attention to the smallest details, and excellent draftsmanship. Koike's subjects tend to be unique aircraft ignored by other artists—there are four flying boats, yet not a single painting of aircraft that are staples of other artists, such as the P-51 Mustang. The combination of Koike's talent and his interest in portraying aspects of aviation that other artists overlook makes this book a treasure.

—J. Campbell Martin is the External Affairs Director for NASA's Dryden Flight Research Center at Edwards, California and is active with the American Society of Aviation Artists.

The Rescue of Bat 21 *by Darrel D. Whitcomb. Naval Institute Press, 1998. 196 pp., $27.95 (hardcover).*

On April 2, 1972, a North Vietnamese surface-to-air missile blasted an EB-66C electronic warfare aircraft known by its radio call sign, "Bat 21," out of the sky. One of its crew members survived—and parachuted into the middle of a North Vietnamese invasion. When he fell to earth behind rapidly shifting battlelines, 53-year-old Air Force navigator Lieutenant Colonel "Gene" Hambleton became the object of the greatest air-land rescue effort of the Vietnam War.

The attempt to rescue Hambleton also became the stuff of legend. In the 1980s, a book and motion picture about the ordeal portrayed Hambleton as unique among downed airmen of the Vietnam era because of his knowledge of highly sensitive information and proposed that the extraordinary effort to save him might not have been made for someone else. The myth dies hard, and it has taken this new book to kill it.

The Rescue of Bat 21 is a gripping account of the 12-day rescue effort. Caught up in the effort were men from all service branches, including the Coast Guard. The unorthodox rescue operation claimed the lives of 11 soldiers and airmen, destroyed or damaged several aircraft, and put at risk hundreds of

airmen, a South Vietnamese infantry division, and a secret commando unit. More than 800 strike sorties, including B-52 missions, were flown in direct support of the rescue.

Author Darrel D. Whitcomb flew OV-10 Bronco forward air control aircraft in Southeast Asia and is an Air Force Reserve colonel today. He uses lean, straightforward language to tell the intricate and riveting story of how the rescue unfolded. The author interviewed most of the key figures in the story, which involved rescue helicopters (one of which, "Jolly 67," was shot down, with six men killed), Skyraider attack aircraft, and ultimately a ground and naval operation. Whitcomb also uncovered photos of aircraft, people, and places that have not previously appeared in print, although the quality of photographic reproduction in the book—even the author's portrait on the flyleaf—is poor.

The Rescue of Bat 21 would be an excellent read for anyone interested in air operations in Vietnam. It is thoroughly researched, documented, and footnoted, without feeling scholarly. It sets forth a story of heroism in battle that is well-paced and precise. The reader will learn everything that happened while Hambleton was on the ground, including the final effort that earned SEAL Lieutenant Tom Norris a Medal of Honor—but will not be distracted by other happenings in the world at the time or by extra detail about the participants' lives. There is a touching postscript about the burial at Arlington National Cemetery of the "Jolly 67" crew, which was not brought home until 28 years after it had been shot down.

As a pure aviation topic, this account is a revealing look at how many different kinds of aircraft and missions intersect in the midst of a raging battle. Was the rescue effort worth the cost? Whitcomb says that "airmen [believed] that if they were hit and had to eject behind enemy lines, regardless of the location or situation, their buddies would not abandon them and rescue crews would make every effort possible to find them and get them out." But the high cost provoked a debate to which Whitcomb devotes an entire chapter, and the reader is invited to decide.

Is this book worth the price? At $27.95, this hardback measures only 9 1/2 by 6 1/2 inches—the scaled-down format that may soon be standard in an era of stratospheric paper prices. Good binding and a sharp design are undercut by the poor photo reproduction. Even so, *The Rescue of Bat 21* is a must.

—Air Force veteran Robert F. Dorr is the author of Vietnam Air War Debrief *(Aerospace Publishing, 1996).*

Space and the American Imagination
by Howard E. McCurdy. Smithsonian Institution Press, 1997. 294 pp., $29.95 (hardcover).

In a 1949 Gallup poll, only 15 percent of those interviewed believed that "men in rocket ships will reach the moon within the next 50 years." Sixty-three percent, however, believed that atomic-powered trains and airplanes would appear in the same period. By 1955, 38 percent believed in a moon flight within 50 years, and after the 1957 launch of Sputnik, 41 percent thought such a flight would be made within 25 years. As Howard McCurdy argues, this shift in perception had much to do with a propaganda campaign launched by the likes of Wernher von

Braun, Willy Ley, Walt Disney, and *Collier's* magazine. They sold space travel with a number of arguments, including its Cold War benefits, its contribution to life on Earth, the possibility it would solve the mysteries of extraterrestrial life, and its positive impact on the American "pioneer spirit."

With the sudden arrival of the Space Age in 1957, the impact of space advocacy on the American imagination only grew. But, McCurdy asserts, the traditional arguments eventually came into conflict with reality. Moonbases and space tourism did not materialize; the world of *2001* still looks far away in 1998. Yet space advocates soldier on, struggling with lukewarm public support, the absence of a cold war enemy, and the continuing huge expense of human spaceflight.

All of this and more makes *Space and the American Imagination* an important book. Open-minded believers in space exploration will gain much from the author's examination of many arguments usually associated with it—a particularly strong chapter is "The Extraterrestrial Frontier," which shows how the American myth of Western settlement has influenced the space program—and why that influence is of questionable value. As a public policy specialist, McCurdy also shows how important culture and works of imagination can be for the formation of government programs. Sometimes he fails to carefully distinguish between American culture and that of the West in general, but this is a minor flaw. He has written a work that has the power to make one rethink the past, present, and future of space exploration.

—Michael Neufeld is a curator in the aeronautics department at the National Air and Space Museum.

CREDITS

The Box. Ralph Kahn, a Jet Propulsion Laboratory research scientist and member of the EOS-MISR team, writes about earth and space science issues.

The President's Plane Is Missing. Frequent contributor Lester A. Reingold has flown on many aircraft, from a Stearman to the Concorde, but his most powerful moments on board an airplane were on SAM 26000.

Aiming for Arkalyk. After many years in Moscow, Craig Mellow has moved to London, where he now writes for *Institutional Investor.*

Nikolai Ignatiev has photographed for such publications as *Time, Life, Stern, Geo,* and *Spiegel.*

Counterpunch. Robert A. Hanson is a freelance writer who lives in Olathe, Kansas. A career fighter pilot, he is a retired U.S. Air Force lieutenant colonel who flew 122 combat missions in Vietnam in the F-4E and was awarded both the silver and bronze stars.

"Live, From the Chopper..." Phil Scott is a frequent contributor who lives in New York City.

Flying the Gusmobile. A screenwriter and pilot, D.C. Agle spends his unloggable hours toiling on a script about early stunt aviator Lincoln Beachey.

Web Bryant is one of the founders of *USA Today,* where he works as a senior illustrator.

Out to Pasture. Michael Dempsey is a freelancer living in London who writes about technology and business for the *Financial Times.*

Shooting in his native England was a rare pleasure for London-based photographer Michael Freeman, who spends most of the year working on foreign assignments.

The Rescue of Eddie Rickenbacker. W. David Lewis is Distinguished University Professor in the history department at Auburn University in Alabama. He has co-authored books on the history of Delta Air Lines and All American Aviation, and is now writing a biography of Eddie Rickenbacker.

Lifeboat. Preston Lerner is a regular contributor.

Rocket Country. Damond Benningfield is a freelance science and technology writer who lives in Austin, Texas.

CALENDAR

August 7–9
Balloon Festival. Alexandria Field, Pittstown, NJ, (908) 735-0870.

August 8
Bob Hall Memorial Fly-In. Halstead Airport, Halstead, KS, (316) 830-2716.

August 8–14
National Model Rocket Championships. Muncie, IN, (717) 456-5570.

August 16
Vintage Aircraft Display and Ice Cream Social Fly-In. Capitol Airport, Brookfield, WI, (414) 350-5512.

August 21–23
Prairie Air Show. Central Illinois Regional Airport, Bloomington, IL, (309) 829-5701.

August 22 & 23
Rochester Airshow. Greater Rochester International Airport, NY, (716) 234-2325.

August 29 & 30
"Thunder in the Air" Airshow. Thunder Bay, Ontario, Canada, (800) 463-8817.

September 5–7
Cleveland National Air Show. Burke Lakefront Airport, Cleveland, OH, (216) 781-0747.

September 12 & 13
Air Classic Airshow. Smith Reynolds Airport, Winston-Salem, NC, (336) 661-1363.

FINA Dallas Air Show. Love Field, Dallas, TX, (214) 350-3600.

September 13
Pope Air Force Base Open House. Fayetteville, NC, (910) 394-1724.

September 19
Air Festival '98. Pueblo Memorial Airport, Pueblo, CO, (719) 948-4964.

September 19 & 20
Air Victory Museum Air Fair and Air Show. South Jersey Regional Airport, Medford, NJ, (609) 267-4488.

Mid-America Air Museum Air Show. Liberal Municipal Airport, KS, (316) 624-5263.

Old-Fashioned Fly-In. Whiteside County Airport, IL, (630) 543-6743.

September 26 & 27
Aerial Circus. Panama City Beach, FL, (850) 233-5070.

ON THE WEB SITE

NASA

GeminiCam

Want to see what your view would have been if you'd sat in the command-pilot's seat during reentry on the unmanned Gemini 2 mission? Check out the video footage from a camera that was there: **www.airspacemag.com/ASM/mag/supp/AS98/Gemini.html**. Also learn the locations of the last remaining Gemini spacecraft.

FORECAST

In the Wings...

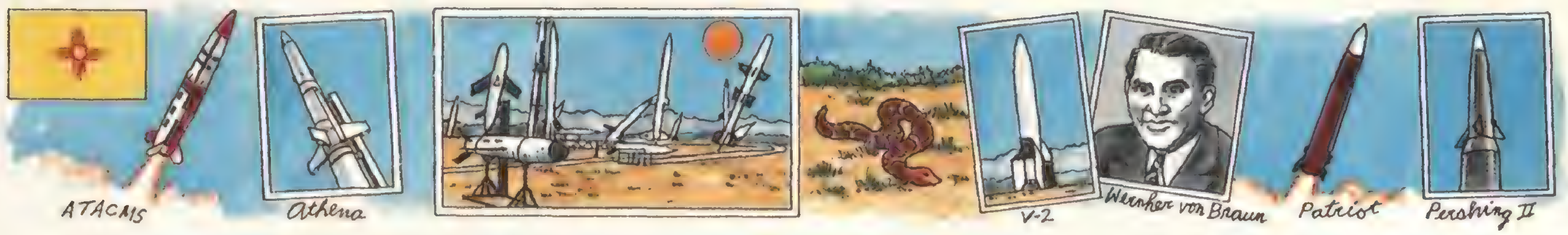
FREE V-22 POSTER!
It's a helicopter...it's a plane...no, it's the V-22 Osprey. The long-awaited military special operations transport has graduated from demo flights. What's next for the hybrid aircraft?

The First. Who is the man behind the myth of Yuri Gagarin?

Naval Warfare. In the latest round of the fight over warbirds, the Navy and an aviation archaeologist engage in a custody battle for a rare Grumman F6F Hellcat.

Overpowering Ambition. The space shuttle main engine is the most powerful, most efficient liquid rocket engine ever built. Why is it being modified?

New Era for Air Police. The Royal Canadian Mounted Police air crew bid farewell to the de Havilland DHC-6 Twin Otter and move up to the sleeker Pilatus PC-12. But not everyone is thrilled.



JOHN HEINLY

Rocket Country

Legend says that millions of dollars' worth of Spanish coins and gold bars lie buried under Victorio Peak on New Mexico's White Sands Missile Range. To students of aerospace history, however, the property's real treasure was discovered in 1994, when construction crews unearthed a half-century-old trash dump. Archeologists summoned to the site discovered medicine containers, beer and soft drink bottles, mess kits, military insignia, a shell casing, vacuum tubes, and a radio panel with German labels—all left by a team working for Wernher von Braun, father of both the German V-2 missile and the U.S. Saturn rocket.

Many of these weathered goodies are now on display at the White Sands Missile Range Museum, flanked by other artifacts reflecting the range's history. There's the first picture of Earth taken from space (snapped in 1948 by a V-2 launched from White Sands) and the world's smallest rocket—a three-inch midget launched from the facility in the late 1960s to determine if radar could track such a small, high-speed target (it couldn't).

White Sands Proving Ground—the range's original name—was established on July 9, 1945, just one week before Manhattan Project scientists detonated the world's first atomic bomb at Trinity Site, on the northern part of the property. The current range comprises about 3,200 square miles of south-central New Mexico's Tularosa Basin, including the white gypsum dunes for which the facility is named.

Though operated by the U.S. Army, the range supports missile and rocket tests conducted by all branches of the military, NASA, and other agencies, plus the militaries and scientific organizations of U.S. allies. It provides launch pads, tracking equipment, personnel, and plenty of open desert in case things go wrong. Launch towers sprout from the landscape like metal prickly pear, and tracking stations and radio antennas occupy every mountaintop and ridge from horizon to horizon. On a recent afternoon, flashing lights warned drivers that the highway bisecting the range was closed for a test firing. Presently, a rocket flashed into view, then quickly disappeared through a thin layer of clouds. Range officials close the highway for such tests once or twice a week.

Visitors to the range's museum start their tour at nearby Rocket Park, which displays more than 50 rockets, missiles, and aircraft, all of which were tested at White Sands. A Patriot missile launcher is stenciled with the boast "Scud Buster—If It Flies, It Dies!" After that comes a heady assortment of rockets—Athena, Sidewinder, Falcon, Nike Hercules. There's a Redstone ballistic missile, like the ones that lofted Alan Shepard and Virgil "Gus" Grissom on the Mercury flights of the early 1960s. Perhaps the park's most entertaining artifact is a saucer-shaped "aeroshell" that NASA used in the mid-1960s to test a planetary probe landing system. The aeroshell was test-launched by balloon from nearby Roswell—which knows a thing or two about flying saucers—and recovered at White Sands.

A block away stands the Rocket That Made White Sands Famous: the V-2. Designed by von Braun and his team in Germany during World War II, the weapon was used primarily against London and Antwerp. After the war, the U.S. Army brought von Braun and his colleagues, plus 300 railroad cars of V-2 parts and equipment, to White Sands to show Americans how to build and fly large rockets. Between 1946 and 1952, more than 60 V-2s were launched from the range, most carrying instruments for astrophysical research (see "Richard Tousey and His Beady-Eyed V-2s," June/July 1986). The specimen now on display is one of only five V-2s left in the world. Inside, the museum exhibits related artifacts: an original V-2 engine, a rocket control unit that was probably built by laborers in German concentration camps, and intricate hand-carved scale models of a battle ready V-2 and its support equipment, which the Germans may have used in plotting strategy with war maps.

The V-2 was only the beginning for White Sands. In October 1947 the range lofted the first man-made object to escape Earth's gravity: a metal pellet the size of a ball bearing that was blasted away from an explosive nose cone in space. Over the next half-century, the range has hosted military missile tests by the thousands, along with tests of the Apollo command module's escape tower, the vertical-takeoff-and-landing DC-X Delta Clipper, and various laser weapons.

In addition to hardware, the museum documents the people who built the earliest rockets flown in the New Mexico desert. The first room houses the White Sands Hall of Fame, which includes memorabilia from von Braun; Colonel Harold R. Turner, the first range commanding officer; and Clyde Tombaugh, the astronomer who discovered Pluto.

In addition to observing, Tombaugh's work at White Sands included designing and building telescopes and tracking cameras. Once, employees at the museum found a Tombaugh-designed telescope sitting in a warehouse and passed it along to the designer so he could tell them about its construction and use. Tombaugh kept it for a few weeks, carefully resurfacing the mirrors and covering them with cardboard shields. When he finally returned it, the astronomer included a letter scolding the museum for letting the mirrors go to ruin and declaring that the covers must never be taken off the mirrors again. They're still there today.

—Damond Benningfield

White Sands Missile Range Museum, White Sands Missile Range, NM 88002. Phone (505) 678-2250 or 678-8824. Open Mon.–Fri., 8 a.m.–4:30 p.m. Admission free. To enter the range, drivers must present license, vehicle registration, and proof of automobile insurance.

PLANET EARTH
A COMMEMORATIVE EARTH DAY POSTER FROM THE APRIL 1990 SMITHSONIAN

A Special Supplement

AIR&SPACE

Smithsonian

BUSINESS WINGS

Celebrating the partnership between aviation and American industry

Business and flying have been linked since the invention of the airplane, but in the last 50 years, that partnership has evolved into an industry in its own right. Now a new exhibition at the National Air and Space Museum entitled "Business Wings" celebrates the accomplishments of the business aviation community, in particular its principal organization, the National Business Aviation Association. In 1997, the NBAA began its 50th anniversary year of service to more than 5,200 members, and "Business Wings" is a high point of the organization's celebration.

The exhibition, which opened in June, shows that business aircraft have been instrumental in helping companies to compete more effectively in a world that gets smaller with each passing year.

Business aviation makes use of both fixed-wing and rotary-wing aircraft. Airplanes range in size from an economical four-place single-engine speedster like the Mooney (above) to multi-engine turboprop or jet-powered airliners. In urban areas especially, helicopters help business to fly above traffic and save time. The Bell JetRanger family of light turbine helicopters (right) is the most popular in the world.

Cover photo courtesy of Cessna Aircraft

[TOP] Photo courtesy of NBAA; [BELOW] photo by David W. Almy, NBAA

NBAA's 1954 convention in Dallas, Texas, drew a mix of heavy iron and the new postwar crop of single- and twin-engine models from Cessna, Piper, and Beech.

Pressures of War and a Postwar Boom

In the beginning, the airplane most benefited those firms whose operations were widespread, and during the 1920s and '30s, oil companies, with their scattered drilling fields, pioneered the use of airplanes as business tools. Soon the Great Depression took its toll on every American industry, including aviation, but a growing political crisis in Europe and the prospect of war led the U.S. government to foster the recovery of aircraft manufacturing. When World War II erupted, U.S. industry lagged in aircraft technology, but it soon caught up and became a mighty arsenal for the Allies, producing such advanced aircraft as the North American P-51 Mustang and Boeing B-29 Superfortress.

After the war, American businessmen found themselves with surplus airframes and a population of highly trained pilots. Equally important, wartime construction of airports, along with the development of increasingly sophisticated electronic navigation aids, provided a national infrastructure of airways that led directly to reliable all-weather air transportation. Airlines were the early beneficiaries of the technology, with 42 airports sporting Instrument Landing Systems by 1947, but business aircraft were soon to follow.

In order to ensure that business aviation got access to a fair share of the nation's increasingly crowded airways, concerned companies formed the Corporation Aircraft Owners Association (CAOA) in February 1947. The fledgling group had only 18 members, but among them were many leaders in their respective industries.

A New Generation Emerges

Although the biggest firms preferred aircraft with at least two engines, many smaller companies opted for one of a growing array of light single-engine aircraft. Beech Aircraft's introduction of the revolutionary model 35 Bonanza in 1945 started a decades-long race among the leading three lightplane makers: Beech, Cessna, and Piper. The single-engine Bonanza was sleek, fast, and well-equipped, but it quickly led to a proliferation of twin-engine airplanes based on engines manufactured by Lycoming and Continental. As the military and airline-style twins with their bigger radial engines began to fade from the scene, a new generation, beginning with Ted Smith's brilliant Aero Commander in 1952, entered the market. When President Dwight Eisenhower began commuting to his farm in Gettysburg, Pennsylvania, in a Commander, light twins gained a reputation for safety and reliability. Soon Cessna debuted the model 310 and Piper rolled out its first twin, the Apache. It was during this period of the early 1950s that the CAOA became the National Business Aircraft Association, perhaps better known simply as the NBAA.

With airliners getting bigger and business airplanes getting smaller, the disparity in serv-

By the Editors of Air & Space/Smithsonian

Design: Lasko Design

Photo courtesy of NBAA

The postwar era's most spectacular entrant was the Beech Bonanza, a speedy, well-equipped single for the business flier. Engines from Lycoming and Continental would power this new generation of aircraft.

ice began to show as big cities got the largest share of the expanding airline service. Business airplanes could launch from any airport and land anywhere else, and they could schedule trips to meet their companies' needs. As industry spread beyond the reach of major hubs, smaller local airports became important business destinations. To serve this traffic, fixed-base operators—service stations for aircraft—began to upgrade their facilities and expand to more airports.

Roar of Recip, Whine of Jet

In 1951, the U.S. Air Force announced that its entire fleet would be turbine-powered. A year later, the first jet airliner, the de Havilland Comet, entered service. The turbine was not an instant success, but in 1959, when Grumman introduced a big turboprop twin called the Gulfstream I into the business airplane market, the reciprocating engine's days were numbered. An Air Force competition in the late 1950s produced two early jet-powered airplanes that matched the needs of company fliers perfectly: the Lockheed JetStar and the North American Sabreliner.

The turbine's speed and reliability won over nearly every company that tried it, and soon there were a dozen new airplanes to choose from. At the same time, the introduction of turboshaft engines ushered in a whole new generation of light helicopters ideally suited to business. The introduction of the turbine was the single greatest spur to progress in the short history of business flying and led to the creation of dazzling airplanes and helicopters that make up today's fleet.

The Once and Future Business Fleet

When William Lear, an inventor and entrepreneur, decided that a Swiss attack fighter could serve as the basis for a business jet, the Lear Jet 23 was born. It had a much smaller cabin than those of other business airplanes, but since many of its buyers were bosses who liked to do their own flying, who cared about the room in back? The airplane barely beat the Jet Commander to market and became a legend. Even today its name is synonymous with an entire category, just as Piper Cub became a synonym for any light airplane.

France's Falcon was personally selected by Charles Lindbergh, who in 1963 wired Pan American World Airways (the airline had been appointed distributor for the Western Hemisphere): "We have our plane." The Dassault-built Falcon pioneered use of an engine called the fanjet—a General Electric CF700—in which a large fan propelled cool air through a duct around the hotter turbine exhaust gases, boosting efficiency and reducing noise.

Beech Aircraft took a piston-powered twin called the Queen Air and installed Pratt & Whitney Canada PT-6A turboprop engines, creating at a stroke the King Air, America's first light twin-turboprop business aircraft. The King Air hangs high over the new exhibition at the National Air and Space Museum, just as it dominates business travel in terms of the sheer number operating worldwide. Today Beech is part of the Raytheon Corporation, and through acquisitions of Hawker's and Mitsubishi's business jets, it manufactures a complete line of both turboprops and pure jets for business.

When Cessna Aircraft entered the increasingly crowd-

Photo courtesy of Flying Magazine

With well over 5,000 Raytheon Beech King Airs in operation, this family of aircraft is clearly the dominant choice of business flight operators worldwide. Company travelers value its reliability and comfort.

ed business jet field in the late 1960s, it was the volume leader in light airplane manufacturing. Its entry into the jet marketplace was the straight-wing Citation (originally named the Fanjet 500), powered by two new Pratt & Whitney JT-15D turbofans that brought an unaccustomed hush to airports, which were growing more sensitive to noise. For many companies, the Citation was the perfect introduction to jet operations. With its simple systems and straightforward handling characteristics, the original Citation and its successors would become the most produced business jets in history. The oldest original Citation—it's the second one Cessna built—stands in the center of the "Business Wings" exhibition.

Grumman phased out production of the Gulfstream I turboprop after only 10 years. But it had something far more exciting: the Rolls-Royce Spey-powered Gulfstream II, which combined the comfortable cabin of the G-I with higher speed, long range, and, most important, panache. Gulfstreams are one of the aircraft of choice for Fortune 500 companies.

This list is by no means complete, as each of these significant airplanes has spawned competitors, some of which have faded. But many have thrived, and each year new companies arise with new ideas: single-engine business jets, for example.

There have also been rough patches along the way: The noise issue created pressure for night curfews and limits on airport access; fuel crises have led to calls for limits on flying. But better engines—the incredibly quiet AlliedSignal TFE731, for example—and more efficient airplanes—the new Cessna Citation X is the fastest business jet flying—have provided answers.

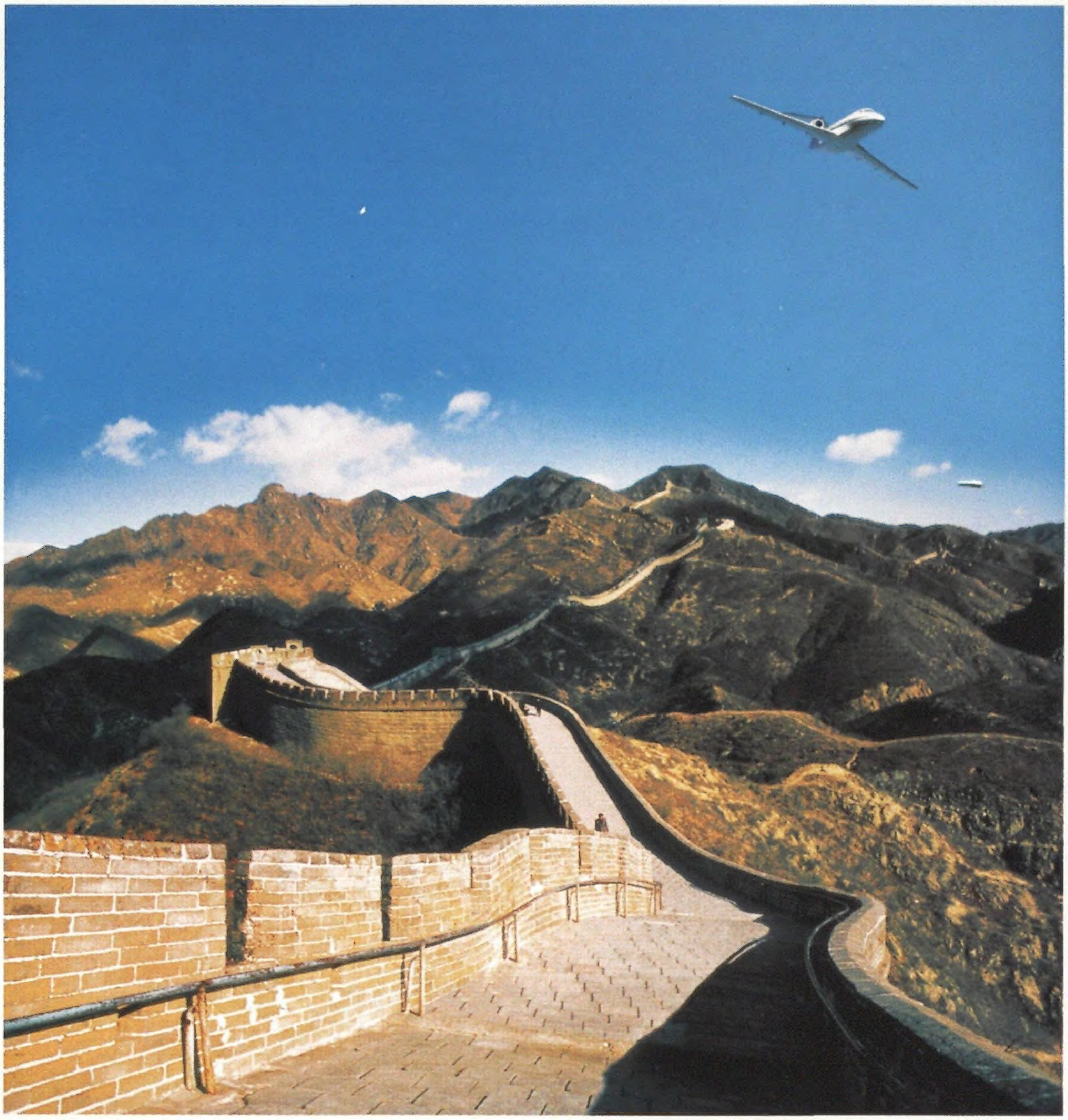
Most recently, the idea of pooling resources through firms such as Executive Jet Aviation, which provides business aircraft on demand with a single phone call, and NetJets, a division of EJA that sells shares in business jets, has multiplied the usefulness of individual aircraft by spreading them around among multiple users. The National Business Aviation Association recently developed computer software called Travel$ense to manage the costs of business flying for companies of all sizes. And the association has undertaken studies proving that those companies using business aircraft are among the most productive and profitable.

As "Business Wings" opened at the National Air and Space Museum, business aircraft surpassed every other category of aircraft in the number on the drawing board, under development, or being flight tested. In the 50 years since the NBAA was founded, business and aviation have proven conclusively to the world that the partnership works.

Rivers, once arteries of commerce for many major cities, now provided inexpensive and convenient access to the downtown area for aircraft equipped to land on water.

[TOP RIGHT] Photo courtesy of Raytheon; [INSET] photo by David W. Almy, NBAA; [BELOW] photo courtesy of NASM

IMAGINE A CITATION THAT'S BEEN FLYING NONSTOP SINCE THE YEAR 856 A.D.



That's how much flight time Citation business jets have logged. The fleet has accumulated an incredible ten million hours of service.

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ABOVE AND BEYOND

NBAA

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LAS VEGAS, NEVADA • OCTOBER 19, 20, 21, 1998

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NBAA's first 50 years have flown by. And the future promises to be even more exciting. Take off with the future of business aviation at the NBAA 51st Annual Meeting & Convention, in Las Vegas, Monday October 19, Tuesday October 20, & Wednesday October 21, 1998.

We're going above and beyond the "gold" to present three days of education, exhibits and networking that no business aviation professional can afford to miss.

Our new name, the National Business Aviation Association, assures that we're moving in the same direction as always...just faster. And, at our 51st Annual Meeting & Convention, we'll be featuring the rapidly-expanding range of state-of-the-art products, services and technologies. There's no better forum to discuss issues most important to vendors and business aviation operators.

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Continuing success is important to us. That's why NBAA Conferences and Seminars are designed to keep you ahead today and into the next millennium. If your job is within the corporate flight department, our programs and expertise provide the tools to work more effectively. We can help you manage a more efficient flight operation through programs highlighting government, safety, management, tax, aircraft maintenance, scheduling, dispatching, and international and domestic operations.

1998 Conference & Seminar Schedule

JANUARY

15-16	Corporate Aviation Management Conference
27-30	Schedulers & Dispatchers Conference

MARCH

2-5	Flight Operations Manual/ Small Flight Department Workshop
16-19	International Operators Conference
20	Communicating With Your Flight Dept.

APRIL

20	Tax Forum

MAY

11-14	Maintenance Management Week *– includes IA Renewal and Maintenance Manual Workshop*

JUNE

19-20	Flight Attendant Conference
22-25	Flight Operations Manual/ Small Flight Department Workshop

JULY

13	Tax Forum

OCTOBER *During NBAA's 51st Annual Meeting & Convention in Las Vegas*

17-18	Flight Instructor Refresher Clinic
17-18	Flight Operations Manual Workshop
17-18	Tax Conference
18	Inspection Authorization (IA) Renewal Certification
21	Maintenance Manual Workshop
22-23	Business Aviation Fatigue Countermeasurers Workshop

(Dates are tentative and subject to change)

For information on how NBAA can take you Above and Beyond,

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